

Feasibility Report - Draft Environmental Impact Statement/Report  
Water Resources Investigation

Saugus River and Tributaries, Lynn, Malden, Revere and  
Saugus, Massachusetts

# Flood Damage Reduction

Volume 4

Appendix

G - Economics

H - Socioeconomic

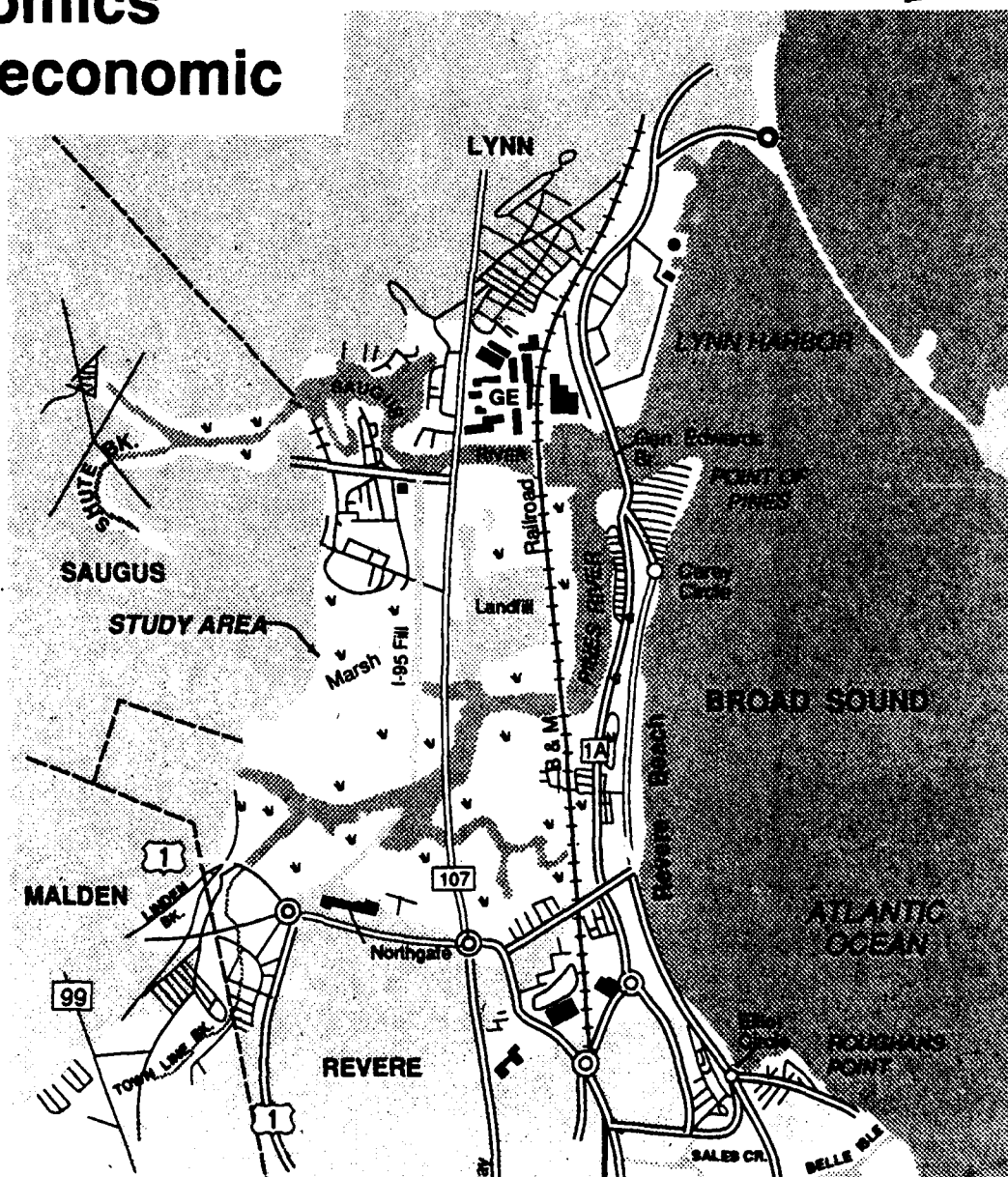
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## **SAUGUS RIVER AND TRIBUTARIES FLOOD DAMAGE REDUCTION STUDY Lynn, Malden, Revere and Saugus, Massachusetts/Summary of Study Reports:**

**Main Report and Environmental Impact Statement/Report (EIS/EIR):** Summarizes the coastal flooding problems in the study area and alternative solutions; describes the selected plan and implementation responsibilities of the selected plan; and identifies environmental resources in the study area and potential impacts of alternative solutions, as required by the Federal (NEPA) and state (MEPA) environmental processes.

**Plan Formulation (Appendix A):** Provides detailed information on the coastal flooding problem and the alternatives investigated; includes: sensitivity analyses on floodgate selection (including location and size of gates and sea level rise); optimization of plans; comparison of alternative measures to reduce impacts; and public concerns.

**Hydrology and Hydraulics (Appendix B):** Includes descriptions of: the tidal hydrology and hydrology of interior runoff in the study area, and of wave runoff and seawall overtopping, interior flood stage frequencies, tide levels, flushing, currents, and sea level rise effects without and with the selected project for various gated openings.

**Water Quality (Appendix C):** Includes descriptions of existing water quality conditions in the estuary and explores potential changes associated with the selected plan.

**Design and Costs (Appendix D):** Includes detailed descriptions, plans and profiles and design considerations of the selected plan; coastal analysis of the shorefront; detailed project costs; scope and costs of engineering and design; scope and costs of operation and maintenance; and design and construction schedules.

**Geotechnical (Appendix E):** Describes geotechnical and foundation conditions in the study area and the design of earth embankment structures in the selected plan.

**Real Estate (Appendix F):** Describes lands and damages, temporary and permanent easements and costs of the selected plan, including the five floodgate alignments studied.

**Economics (Appendix G):** Describes recurring and average annual damages and benefits in study area floodzones; economic analysis and optimization of alternative plans.

**Socioeconomic (Appendix H):** Describes the socioeconomic conditions in the study area and the affects of the selected plan on development in the floodplain and estuary.

**Planning Correspondence (Appendix I):** Includes all letters between community officials, agencies, organizations and the public and the Corps prior to agency and public review of the draft report.

**Feasibility Study and EIS/EIR Comments and Responses (Appendix J):** Includes all comments and Corps responses to letters received during agency and public review.

**Environmental (Appendix K):** Includes basic data from investigations of environmental resources in the study area and presents the Mitigation Incremental Analysis.

**SAUGUS RIVER AND TRIBUTARIES  
FLOOD DAMAGE REDUCTION STUDY**

**LYNN, MALDEN, REVERE  
AND SAUGUS, MASSACHUSETTS**



**ECONOMICS**

**APPENDIX G**

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## TABLE OF CONTENTS

	<u>PAGE</u>
Introduction	G-5
Methodology	G-5
Flood Damage Survey	G-5
Affected Area	G-7
Flood Damage Computation	G-9
Recurring Losses	G-9
Annual Losses	G-27
Emergency Costs	G-29
Flood Insurance Overhead	G-32
Future Flood Losses	G-32
Residential and Commercial Development	G-33
Increased Contents Value (Affluence)	G-33
Sea Level Rise	G-34
Damage to Shorefront Structures	G-34
Summary of Annual Losses	G-34
Plans of Improvement	G-35
Economic Benefit Estimation	G-36
Innundation Reduction - Primary Flood Losses	G-37
Damage Prevention to Shorefront Structures	G-49
Location Benefit	G-50
Intensification Benefit	G-50
Recreation Benefit	G-50
Impact of Future Sea Level Rise	G-54
Summary of Benefits	G-55
Project Optimization	G-56
Sensitivity Analysis	G-65

# LIST OF TABLES

<u>Table Number</u>	<u>Description</u>	<u>Page</u>
1	Categories of Residential Structures	G-6
2	Damages Included in Flood Damage Survey	G-7
3	Recurring Losses, Lynn - Zone 1 (com/ind)	G-10
4	Recurring Losses, Lynn - Zone 1 (res)	G-10
5	Recurring Losses, Lynn - Zone 2 (G.E.)	G-10
6	Recurring Losses, Lynn - Zone 3 (res)	G-11
7	Recurring Losses, Lynn - Zone 3 (com/ind)	G-11
8	Total Recurring Losses, Lynn - All Zones (res)	G-11
9	Total Recurring Losses, Lynn - All Zones (com)	G-12
10	Recurring Losses, Saugus - Zone 1 (com/ind)	G-12
11	Recurring Losses, Saugus - Zone 1c (com/ind)	G-13
12	Recurring Losses, Saugus - Zone 1 (res)	G-13
13	Recurring Losses, Saugus - Zone 2 (com/ind)	G-14
14	Recurring Losses, Saugus - Zone 2 (res)	G-14
15	Recurring Losses, Saugus - Zone 3 (com/ind)	G-14
16	Recurring Losses, Saugus - Zone 3 (res)	G-15
17	Recurring Losses, Saugus - Zone 3A (com/ind)	G-15
18	Recurring Losses, Saugus - Zone 3A (res)	G-16
19	Recurring Losses, Saugus - All Zones (com/ind)	G-16
20	Recurring Losses, Saugus - All Zones (res)	G-16
21	Recurring Losses, Revere - Zone 1 (res)	G-17
22	Recurring Losses, Revere - Zone 1 (com/ind/pub)	G-17
23	Recurring Losses, Revere - Zone 2A (com/ind/pub)	G-17
24	Recurring Losses, Revere - Zone 2B (res)	G-18
25	Recurring Losses, Revere - Zone 2B (com/ind/pub)	G-18
26	Recurring Losses, Revere - Zone 3A (res)	G-18
27	Recurring Losses, Revere - Zone 3A (com/ind/pub)	G-19
28	Recurring Losses, Revere - Zone 4A (res)	G-19
29	Recurring Losses, Revere - Zone 4A (com/ind/pub)	G-19
30	Recurring Losses, Revere - Zone 4B (res)	G-20
31	Recurring Losses, Revere - Zone 4B (com/ind/pub)	G-20
32	Recurring Losses, Revere - Zone 4C (res)	G-20
33	Recurring Losses, Revere - Zone 4C (com/ind/pub)	G-21
34	Recurring Losses, Revere - Zone 5A (res)	G-21
35	Recurring Losses, Revere - Zone 5A (com/ind/pub)	G-21
36	Recurring Losses, Revere - Zone 5B (res)	G-22
37	Recurring Losses, Revere - Zone 5B (com/ind/pub)	G-22
38	Recurring Losses, Revere - Zone 6 (res)	G-22
39	Recurring Losses, Revere - Zone 6 (com/ind/pub)	G-23
40	Recurring Losses, Revere - Zone 7A (res)	G-23
41	Recurring Losses, Revere - Zone 7A (com/pub)	G-23
42	Recurring Losses, Revere - Zone 7B (res)	G-24
43	Recurring Losses, Revere - Zone 7B (com/pub)	G-24
44	Recurring Losses, Revere - Zone 7C (res)	G-24
45	Recurring Losses, Revere - Zone 7C (com/pub)	G-25

46	Recurring Losses, Revere - Zone 7D (res)	G-25
47	Recurring Losses, Revere - Zone 7D (com/pub)	G-25
48	Recurring Losses, Revere - All Zones (res)	G-26
49	Recurring Losses, Revere - All Zones (com/ind/pub)	G-26
50	Summary of Recurring Losses; Lynn, Saugus & Revere	G-27
51	Average Annual Losses - Lynn	G-28
52	Average Annual Losses - Saugus	G-28
53	Average Annual Losses - Revere	G-29
54	Emergency Organizations Involved in Revere - 1978	G-30
55	Per Capita Income, Boston NECMA (1983-2035)	G-34
56	Annual Flood Losses - Without Project	G-35
57A	Reduction of Primary Flood Damages - Plan 1, Revere Backshore	G-38
57B	Reduction of Primary Flood Damages - Plan 1, Revere Northgate	G-39
57C	Reduction of Primary Flood Damages - Plan 1, Revere Point of Pines	G-40
58	Reduction of Primary Flood Damages - Plan 1, Saugus	G-41
59	Reduction of Primary Flood Damages - Plan 1, Lynn	G-42
60	Reduction of Primary Flood Damages - Plan 2, Revere, Saugus and Lynn	G-42
61	Reduction of Primary Flood Damages - Plan 3, Revere	G-43
62	Reduction of Primary Flood Damages - Plan 3, Saugus	G-45
63	Reduction of Primary Flood Damages - Plan 3, Lynn	G-46
64	Plan 1 Benefits - Lynn, Saugus, Revere	G-47
65	Plan 2 Benefits - Lynn, Saugus, Revere	G-48
66	Plan 3 Benefits - Lynn, Saugus, Revere	G-48
67	Damage Prevention to Shorefront Structures	G-49
68	Guidelines for Assigning Recreational Benefits	G-51A
69	Point Values	G-51A
70	Recreational Value	G-53
71	Demand for Park Activity Days	G-54
72	Impact of Sea Level Rise on Losses and Benefits	G-54
73	Benefits and Costs, Plan 1, 2 and 3	G-55
74	Optimization of Floodgate Plan, Alignments 1 and 2	G-56
75	Optimization of Floodgate Plan, Alignments 3, 4, and 5	G-58
76	Optimization of Plan 1 - Lynn	G-59
77	Optimization of Plan 1 - Saugus	G-60
78	Optimization of Plan 1 - Revere, Point of Pines	G-61
79	Optimization of Plan 1 - Revere Backshore	G-62
80	Optimization of Plan 1 - Revere Northgate	G-63
81	Optimization of Plan 1 - Revere	G-64
82	Optimization of Plans	G-64

## Introduction

The purpose of this report is threefold. The first is to determine the extent to which the flood control needs of the area are met by each alternative plan of improvement. This is accomplished by estimating the dollar value of flood reduction benefits produced by each plan. Secondly, each plan's measure of economic justification will be ascertained through the calculation of its benefit/cost ratio. The total dollar value of the annual benefits to be realized over the plan's economic life are divided by the annual changes for the plans total cost. A benefit/cost ratio of 1.0 or greater is necessary for Federal participation in water resources improvement projects. Thirdly, the plan that maximizes net benefits (i.e. total annual benefits minus total annual costs) will be identified from all justified plans. This plan is the one that allocates resources in the most efficient manner and therefore provides the greatest return on public investment.

## Methodology

This report presents the economic benefit from reducing actual or potential flood damages in Lynn, Saugus, and Revere. Economic justification of plans to reduce flooding damages is determined by comparison of average annual benefits and costs of projects over their economic lives.

Benefits and costs are made comparable by conversion to average annual equivalents. An interest rate of  $8 \frac{7}{8}\%$ , as specified in the Federal Register, is to be used by Federal agencies in the formulation and evaluation of water and related land resource plan for the period, 1 October 1988 to 30 September, 1989. All costs and benefits are stated at the 1988 price level. The project economic life is considered to be one hundred years. The analysis of costs and benefits follows standard U.S. Army Corps of Engineers procedures. The reference document used in the benefit estimation process is the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies; 10 March 1983; Section IV - NED Benefit Evaluation Procedures. Urban Flood Damage.

## Flood Damage Survey

Damage surveys were performed in 1986 for Lynn and Saugus and in 1982 for Revere by flood damage evaluators from the New England Division. The objective of the flood damage survey is to estimate potential flood related damage and losses for each property in the floodplain for each possible flood stage. The floodplain includes residential, commercial, industrial and public structures. For all but residential properties stage-damage relationships were developed based upon interviews with occupants and local officials. The stage at which flood damage begins was determined for each property. Estimates of potential damages were then made from the starting point, in one foot increments of stage, to a level of at least 3 feet above the stage of the February 1978 flood. Dollar value estimates were made for physical damages to site, structure, contents and utilities. Damages were assumed to start in a building when water reached the first opening. Seepage through the bottom of the foundation was not assumed as the start of damage. Estimates of income

losses to businesses and wage losses to employees resulting from a disruption of normal activities were also determined. Industries and businesses where these nonphysical losses have not been estimated include General Electric as well as the rest of Lynn and Saugus. Nonphysical losses were not estimated because of the difficulty of documentation given the availability of study funds.

Stage damage estimates for residential properties were prepared using typical stage damage relationships for 15 categories of residential structures. The 15 categories are listed in Table 1. The typical stage damage relationships were originally developed for two previously completed flood damage reduction studies, Roughan's Point (Revere, MA) and Point of Pines (Revere, MA), and are subsequently reviewed and revised for use in this study. The types of damages included in the estimates are displayed in Table 2. Damage estimates were referenced to the first floor of the residence and made in one foot increments.

First floor and ground elevations at each building were either surveyed for elevation or obtained from spot elevations on topographical mapping (1-inch = 100 ft., two foot contours). The elevations were taken from the same source as high water marks used to develop stage frequency curves. The development of stage frequency curves is discussed in the Hydrology and Hydraulics Appendix.

TABLE 1  
CATEGORIES OF RESIDENTIAL STRUCTURES

1.	One Family,	One Story,	No Basement (small)
2.	One Family,	One Story,	Unfinished Basement (small)
3.	One Family,	One Story	Finished Basement (small)
4.	One Family,	One Story	No Basement (large)
5.	One Family,	One Story	Unfinished Basement (large)
6.	One Family,	One Story	Finished Basement (large)
7.	One Family,	Two Story	No Basement
8.	One Family,	Two Story	Unfinished Basement
9.	One Family,	Two Story,	Finished Basement
10.	One Family,	Split Level	Finished Basement
11.	Duplex,	Two Story	No Basement
12.	Duplex,	Two Story	Unfinished Basement
13.	Two Family,	Two Story,	Unfinished Basement
14.	Three Family,	Three Story	Unfinished Basement
15.	Six Family	Three Story	Unfinished Basement

TABLE 2  
DAMAGES INCLUDED IN SURVEY

1. Basement - structural cleanup and other: basement or cellar floors, Sub-basement foundation, exterior and interior walls, cleaning and carting.

- Utilities: Heat, electricity, plumbing, gas, and air conditioning including losses for possible damage to, removal and replacement of heating plant and water heater, electrical board, water and sewage pipes, sink and lavatory, gas meter and air conditioning unit.

- Contents: Furnishings, tools, sporting equipment, garden furniture and storage chests.

2. Outside - grounds fencing, driveway, storage sheds, pool and landscaping.

3. 1st floor and above - first floor interior and exterior walls, window, doors, and cabinets, fixtures, plumbing and electrical equipment, outlets, and ceilings.

- Contents: Furnishings, refrigerator, freezer, rugs, drapes, clothing, food, pots and pans, dishes, silverware, small appliances, and large appliances (providing they are not in the basement).

- Garage: Car, structure and contents.

4. Non-Physical Losses

One hundred fifty dollars per day per family was estimated for the expense of being out of homes. This includes the cost of shelter and food. In the case of single person \$90 per day is reasonable for lodging, food and incidentals, at this particular time and in this area.

\$60.00 for a room

\$30.00 for food and incidentals, possible clothing.

This \$150.00 figure for families and the \$90.00 per single person were average figures (1984 price level).

Affected Area

The flood plain lies in the communities of Lynn, Saugus and Revere. The major source of flooding is the Pines and Saugus Rivers, as well as overtopping in Lynn Harbor, Revere Beach, and Point of Pines. The locations of damage zones are shown in the Plan Formulation and Hydrology and Hydraulics Appendices. The following 4 damage zones have been designated for the city of Lynn:

<u>Zone</u>	<u>Area</u>
1	Lynn Harbor Coastal
2	Lynn General Electric
3	Saugus and Little Rivers
4	B&M Railroad Tracks to Boston Street

#### Saugus Damage Zones

The study area in Saugus is divided into three hydrologic zones. Zone 1 is east of Ballard Street, Zone 2 is between Bristow and Ballard Streets and Zone 3 is west of Bristow Street.

#### Revere Damage Zones

The study area in Revere is divided into 15 hydrologic zones. Zones are shown below.

<u>Zone</u>	<u>Designation</u>
1.	Crescent Beach
2a.	Wonderland - Ocean Avenue
2b.	Wonderland - Dog Track
3a.	Towle Industry
3b.	Revere High School
3c.	Hill Park
4a.	Oak Island - Kellys Meadow
4b.	Oak Island - Boston & Maine Track/North Shore Road
4c.	Oak Island - Revere House
5a.	Pines River - Riverside
5b.	Pines River - Revere Beach North
5c.	Pines River - Pines River Shore
5d.	Pines River - Outer Oak Island
6.	Northgate
7a-7d	Point of Pines

#### Flood Damage Computation

Flood damages were developed using the "Structure Inventory for Damage Analysis" program (SID) developed by the Corps of Engineers Hydrologic Engineering Center in Davis, California. The program primarily generates elevation-damage functions by damage category and reach. The resulting functions were then used to compute average annual damage by the "Expected Annual Flood Damage Computation Program" (EAD). The SID program allows for the computation of expected average annual damage on a structure by structure basis, thereby providing the flexibility to evaluate both structural and nonstructural flood control plans. Single flood event damage by category and reach can also be determined.

Stage-damage information was input for each nonresidential structure. In the case of residences, stage damage information for each of the 15 categories (Table 1) was input. The elevation of the first floor and the elevation at which damage starts were also input for each structure. Stage-frequency data for each hydrologic zone were then input. The computer model combined stage-frequency data and stage damage information to compute damage frequency and expected annual damage by hydraulic zones.

### FLOOD DAMAGES

#### Recurring Losses

Recurring flood losses are those potential damages which are estimated to occur at various flood stages. Under present day development in Lynn a recurrence of the record February 1978 event (100 year frequency) could cause an estimated \$11 million in damages to residences, \$54 million in damage to commercial industrial, and public structures.

Recurring losses by zone are presented in Tables 3 through 7. Total recurring losses for all zones in Lynn are shown in Tables 8 and 9. In Saugus, it is estimated that the 1978 event could result in \$13 million in damages to residences and \$2 million in damage to commercial, industrial and public structures. Recurring losses in Saugus by zone are presented in Tables 10 through 18. Total recurring losses for all Saugus zones are shown in Tables 19 and 20.

In Revere, the 1978 flood could result in damage to residences of \$22 million and damage to commercial, industrial and public of \$11 million. Recurring losses for Revere are presented in Tables 21 through 47. Total recurring losses for all Revere zones is shown in Tables 48 and 49.

TABLE 3  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
LYNN - ZONE 1, Lynn Harbor Coastal

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures* Affected (Number)	Loss (\$1,000 Feb 1988)
10.2	10	66	\$1,339
10.9	20	89	4,172
11.8	50	124	10,947
12.4	100	142	18,801
13.6	500	165	48,076
15.3	SPN+1**	169	109,698

TABLE 4  
RECURRING LOSSES  
RESIDENTIAL  
Lynn - Zone 1, Lynn Harbor Coastal

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structure Affected (Number)	Loss (\$1000 Feb 1988)
10.2	10	137	\$2,927
10.9	20	208	4,918
11.8	50	271	8,083
12.4	100	315	10,790
13.6	500	394	15,854
15.3	SPN+1'	401	15,854

TABLE 5  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Lynn - Zone 2, General Electric

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structure Affected (Number)	Loss (\$1000 Feb 1988)
10.3	20	N/D	\$6,269
10.8	50	N/D	17,427
11.2	100	N/D	30,903
12.0	500	N/D	73,438
13.8	SPN+1'	N/D	231,819

\* "Structures Affected" refers to ground level flooding.

\*\* SPN+1' represents the SPN coastal flooding with one foot of sea level rise.

TABLE 6  
RECURRING LOSSES  
RESIDENTIAL  
Lynn - Zone 3, Saugus and Little Rivers

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structure Affected (Number)	Loss (\$1000 Feb 1988)
9.1	10	14	\$246
9.4	20	16	299
9.9	50	23	447
10.3	100	26	599
11.2	500	39	1,021
13.0	SPN+1'	106	2,851

TABLE 7  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Lynn - Zone 3, Saugus and Little Rivers\*

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
9.1	10	13	1,739
9.4	20	13	2,342
9.9	50	16	3,643
10.3	100	20	4,764
11.2	500	21	9,376
13.0	SPN+1'	24	17,734

\*Includes Zone 4, Zones have same hydrology and thus were combined for determination of damages.

TABLE 8  
TOTAL RECURRING LOSSES  
RESIDENTIAL  
Lynn - All Zones

Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
10	151	\$3,173
20	224	5,216
50	294	8,530
100	341	11,389
500	433	16,875
SPN+1'	507	18,705

TABLE 9  
TOTAL RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Lynn - ALL ZONES

Recurrence Interval (Years)	Structures <sup>1</sup> Affected (Number)	Loss (\$1000 Feb 1988)
10	79	3,0781
20	102	12,695
50	140	31,912
100	162	54,345
500	186	130,758
SPN+1'	193	359,076

1) Excludes General Electric

TABLE 10  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Saugus - Zone 1, East of Ballard Street (Excludes Zone 1C)

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
9.2	10	3	\$15
9.8	20	4	30
10.5	50	N.D.	N.D.
11.0	100	6	67
12.0	500	6	90
13.9	SPN+1'	6	203

N.D. - Not Determined

TABLE 11  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Saugus - Zone 1C - Ballard St.  
(Rt. 107 to Eastern Tool and northeast of Johnson Street)

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structure Affected (Number)	Loss (\$1000 Feb 1988)
9.2	10	20	\$95
9.8	20	23	158
10.5	50	N.D.	N.D.
11.0	100	25	258
12.0	500	26	339
13.9	SPN+1'	26	1,266

NOTE: Areas 1C and 1B separated from Zone 1 to fascilitate evaluation of project proposed plans. Damages in Zone 1B shown with Zone 1 totals.

TABLE 12  
RECURRING LOSSES  
RESIDENTIAL  
Saugus - Zone 1, East of Ballard Street

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
9.2	10	14	\$290
9.8	20	39	869
10.5	50	N.D.	N.D.
11.0	100	82	2,088
12.0	500	116	2,486
13.9	SPN+1'	143	7,904

N.D. - Not Determined

TABLE 13  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Saugus - Zone 2, Between Ballard and Bristow Streets

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.3	10	3	\$18
N.A.	20	N.D.	N.D.
N.A.	50	N.D.	N.D.
10.7	100	14	1,786
11.9	500	16	4,317
13.9	SPN+1'	16	5,786

TABLE 14  
RECURRING LOSSES  
RESIDENTIAL  
Saugus - Zone 2, Between Ballard and Bristow Streets

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.3	10	110	\$1,789
N.D.	20	N.D.	N.D.
N.D.	50	N.D.	N.D.
10.7	100	232	7,198
11.9	500	257	10,606
13.9	SPN+1'	269	15,333

TABLE 15  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Saugus - Zone 3, West of Bristow Street

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.6	10	6	N.D.
9.2	20	8	\$57
9.9	50	8	86
10.5	100	8	112
11.7	500	8	151
13.9	SPN+1'	8	157

**TABLE 16**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
**Saugus - Zone 3, West of Bristow Street**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.6	10	30	N.D.
9.2	20	55	\$1,768
9.9	50	85	2,650
10.5	100	103	3,580
11.7	500	127	5,511
13.9	SPN+1'	136	7,670

**TABLE 17**  
**RECURRING LOSSES**  
**COMMERCIAL/INDUSTRIAL**  
**Saugus - Zone 3A, West of Bristow St.\***

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.4	10	N.D.	N.A.
9.1	20	4	14
9.9	50	4	31
10.5	100	4	52
11.7	500	4	90
13.9	SPN+1'	4	156

\*Tidal stages are a function of high tide duration, wind speed and wind direction as well as tidal elevation of the Pines River. Therefore, a range of damages is shown as represented by Zones 3 and 3A.

TABLE 18  
RECURRING LOSSES  
RESIDENTIAL  
Saugus - Zone 3A, West of Bristow St.\*

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Flood Loss (\$1000 Feb 1988)
8.4	10	47	N.D.
9.1	20	74	\$1,655
9.9	50	85	2,650
10.5	100	103	3,580
11.7	500	127	5,511
13.9	SPN+1'	137	7,670

\*See footnote, Table 17.

TABLE 19  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL  
Saugus - All Zones

Recurrence Interval (Years)	Structures Affected	Loss (\$1000 Feb 1988)
10	32	128*
20	38	263**
50	38	294***
100	53	\$2,223
500	56	4,879
SPN+1'	56	7,412

\*Excludes Zone 3

\*\*Partial for Zone 2 and excludes Zone 3A.

\*\*\*Partial for Zones 1 and 2, and excludes Zone 3A

TABLE 20  
RECURRING LOSSES  
RESIDENTIAL  
Saugus - All Zones

Recurrence Interval (Years)	Structures Affected	Loss (\$1000 Feb 1988)
10	201	2,079*
20	278	4,426**
50	319	5,308***
100	520	\$12,866
500	627	18,603
10,000	685	30,906
Above max	694	

**TABLE 21**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
**Revere - Zone - 1, Crescent Beach**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected	Loss (\$1000 Feb 1988)
5.0	10	6	\$508
5.6	20	8	782
6.4	50	11	1,205
7.1	100	18	1,547
8.6	500	28	2,393
11.6	SPN+1'	92	2,639

**TABLE 22**  
**RECURRING LOSSES**  
**COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS**  
**Revere - Zone 1, Crescent Beach**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (First Floor)	Loss (\$1000 Feb 1988)
5.0	10	3	\$112
5.6	20	4	239
6.4	50	12	537
7.1	100	12	801
8.6	500	14	1,509
11.6	SPN+1'	15	4,033

**TABLE 23**  
**RECURRING LOSSES**  
**COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS**  
**Revere - Zone 2A, Wonderland - Ocean Avenue**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
7.6	10	6	\$197
8.8	20	8	538
10.4	50	8	1,157
11.4	100	10	1,805
12.9	500	10	2,827
15.0	SPN+1'	10	5,051

**TABLE 24**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
**Revere - Zone 2b, Wonderland - Dog Track**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
5.8	10	26	\$1,349
7.0	20	38	2,178
8.4	50	50	3,189
9.3	100	61	3,925
10.9	500	95	4,094
13.0	SPN+1'	128	4,094

**TABLE 25**  
**RECURRING LOSSES**  
**COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS**  
**Revere - Zone 2b, Wonderland - Ocean Avenue**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 June 1986)
5.8	10	11	\$159
7.0	20	16	458
8.4	50	22	1,730
9.3	100	23	2,819
10.9	500	23	6,080
13.0	SPN+1'	25	8,560

**TABLE 26**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
**Revere - Zone 3a\*, Towle Industry Area**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
5.0	10	0	0
5.4	20	1	\$155
5.7	50	5	434
6.1	100	7	660
8.0	500	15	2,583
12.0	SPN+1'	75	14,049

\* Includes Zones 3a, 3b and 3c.

TABLE 27  
RECURRING LOSSES, REVERE  
COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS  
Revere - Zone 3A\*, Towle Warehouse Area

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
5.0	10	0	\$65
5.2	20	35	116
5.7	50	35	257
6.1	100	35	387
8.0	500	39	1,253
12.0	SPN+1'	43	3,470

\* Includes Zones 3a, 3b, and 3c.

TABLE 28  
RECURRING LOSSES  
RESIDENTIAL  
Revere - Zone 4a, Oak Island - Kelleys Meadow

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structure Affected	Loss (\$1000 Feb 1988)
5.5	10	120	1,450
6.4	20	148	2,329
7.5	50	160	3,338
8.3	100	169	4,015
9.8	500	179	5,465
11.8	SPN+1'	181	6,244

TABLE 29  
RECURRING LOSSES  
COMMERCIAL, INDUSTRIAL AND PUBLIC BUILDINGS  
Revere - Zone 4a. Oak Island - Kelleys Meadow

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
5.5	10	9	\$115
6.4	20	13	213
7.5	50	15	426
8.3	100	16	660
9.8	500	16	1,335
11.8	SPN+1'	16	3,790

**TABLE 30**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
 Revere - Zone 4b, Oak Island - Boston and Maine R.R.  
 Tracks/North Shore Road

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1,000 Feb 1988)
3.7	10	4	\$27
4.3	20	7	57
5.5	50	12	149
6.5	100	19	265
8.2	500	39	619
10.8	SPN+1'	41	619

**TABLE 31**  
**RECURRING LOSSES**  
**COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS**  
 Revere - Zone 4b, Oak Island - Boston and Maine R.R.  
 Tracks/North Shore Road

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
3.7	10	0	\$0
4.3	20	0	0
5.5	50	1	2
6.5	100	1	7
8.5	500	1	27
10.8	SPN+1'	1	40

**TABLE 32**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
 Revere - Zone 4c, Oak Island - Revere House

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
5.8	10	6	\$80
6.1	20	6	87
6.8	50	20	342
7.7	100	25	471
9.5	500	26	597
12.4	SPN+1'	26	597

TABLE 33  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS  
Revere - Zone 4c, Oak Island - Revere House

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
5.8	10	1	45
6.1	20	1	56
6.8	50	2	1,569
7.7	100	2	2,840
9.5	500	2	4,232
12.4	SPN+1'	2	4,233

TABLE 34  
RECURRING LOSSES  
RESIDENTIAL  
Revere - Zone 5a, Pines River-Riverside

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
9.1	10	156	1,603
9.5	20	160	2,141
10.0	50	180	2,736
10.3	100	187	3,103
11.2	500	195	4,294
13.0	SPN+1'	195	7,236

TABLE 35  
RECURRING LOSSES  
COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS  
Revere - Zone 5a, Pines River-Riverside\*

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
9.1	10	9	261
9.5	20	9	486
10.0	50	11	677
10.3	100	11	941
11.2	500	11	1,789
13.0	SPN+1'	11	2,963

\* Zones 5a, 5c and 5d were combined because of identical hydrologies.

**TABLE 36**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
 Revere - Zone 5b, Pines River - Revere Beach North

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
9.1	10	5	55
9.5	20	5	67
10.0	50	49	125
10.3	100	54	254
11.2	500	54	340
13.0	SPN+1'	54	340

**TABLE 37**  
**RECURRING LOSSES**  
**COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS**  
 Revere - Zone 5b, Pines River - Revere Beach North

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
9.1	10	0	0
9.5	20	0	0
10.0	50	0	0
10.3	100	0	0
11.2	500	0	0
13.0	SPN+1'	0	0

**TABLE 38**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
 Revere - Zone 6, Northgate

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
N.D.	10	N.D.	N.D.
9.5	20	12	192
10.2	50	32	615
10.7	100	40	1,036
11.8	500	50	1,730
13.2	SPN+1'	52	2,563

**TABLE 39**  
**RECURRING LOSSES**  
**COMMERCIAL/INDUSTRIAL/PUBLIC BUILDINGS**  
**Revere - Zone 6, Northgate**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
N.D.	10	N.D.	N.D.
9.5	20	0	0
10.2	50	2	5
10.7	100	16	47
11.8	500	18	302
13.2	SPN+1'	19	986

**TABLE 40**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
**Revere - Zone 7a, Point of Pines**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
11.1	10	1	\$538
11.8	20	1	609
12.6	50	6	737
13.0	100	9	839
13.9	500	24	1,093
14.0	1,000	28	1,201

**TABLE 41**  
**RECURRING LOSSES**  
**COMMERCIAL/PUBLIC**  
**Revere - Zone 7a, Point of Pines**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
11.1	10	1	\$5
11.8	20	1	10
12.6	50	1	23
13.0	100	1	41
13.9	500	1	97
14.0	1,000	1	109

**TABLE 42**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
**Revere - Zone 7b, Point of Pines**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
10.2	10	84	\$1,464
10.9	20	106	1,712
11.6	50	112	1,974
12.0	100	112	2,160
12.8	500	113	2,625
13.0	1,000	113	2,882

**TABLE 43**  
**RECURRING LOSSES**  
**COMMERCIAL/PUBLIC**  
**Revere - Zone 7b, Point of Pines**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
10.2	10	1	\$51
10.9	20	1	68
11.6	50	1	93
12.0	100	1	116
12.8	500	1	185
13.0	1,000	1	228

**TABLE 44**  
**RECURRING LOSSES**  
**RESIDENTIAL**  
**Revere - Zone 7c, Point of Pines**

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.7	10	93	\$1,448
9.0	20	107	1,862
9.6	50	113	2,263
10.0	100	115	2,355
10.9	500	119	2,720
11.4	1,000	122	2,810

TABLE 45  
RECURRING LOSSES  
COMMERCIAL/PUBLIC  
Revere - Zone 7c, Point of Pines

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.7	10	3	\$7
9.0	20	3	9
9.6	50	3	17
10.0	100	3	18
10.9	500	3	21
11.4	1,000	3	22

TABLE 46  
RECURRING LOSSES  
RESIDENTIAL  
Revere - Zone 7d, Point of Pines

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.1	10	44	\$679
8.6	20	46	872
9.3	50	50	1,052
9.8	100	52	1,154
11.0	500	52	1,408
11.7	1,000	53	1,605

TABLE 47  
RECURRING LOSSES  
COMMERCIAL/PUBLIC  
Revere - Zone 7d, Point of Pines

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Loss (\$1000 Feb 1988)
8.1	10	2	\$8
8.6	20	2	20
9.3	50	2	53
9.8	100	2	79
11.0	500	2	111
11.7	1,000	2	114

TABLE 48  
RECURRING LOSSES, REVERE  
All Zones  
(Residential)

Recurrence Interval (Years)	Structures Affected (First Floors)	Loss (\$1000 Feb 1988)
10	545	\$9,384
20	645	13,301
50	800	18,608
100	868	22,273
500	989	30,462
SPN+1'	1,160	47,212

TABLE 49  
RECURRING LOSSES, REVERE  
All Zones  
(Commercial, Industrial and Public Buildings)

Recurrence Interval (Years)	Structure Affected (Number)	Loss (\$1000 Feb 1988)
10	46	\$1,083
20	93	2,233
50	115	6,581
100	133	10,574
500	141	16,616
SPN+1'	149	33,575

**TABLE 50**  
**SUMMARY OF RECURRING LOSSES**  
(\$1000's and Feb 1988 Price Level)

	10-YR	20-YR	50-YR	100-YR	500-YR	SPN+1'
<b>LYNN-</b>						
Residential	\$3,173	\$5,216	\$8,530	\$11,389	\$16,875	\$18,705
Commercial	3,078	12,695	31,912	54,345	130,758	359,076
Total	6,251	17,912	40,442	65,734	147,633	377,781
<b>SAUGUS-</b>						
Residential	2,079	4,426	5,308	\$12,866	\$18,603	\$30,906
Commercial	128	263	294	2,223	4,879	7,412
Total	2,207	4,689	5,602	15,089	23,482	38,298
<b>REVERE-</b>						
Residential	\$9,202	\$13,043	\$18,160	\$21,784	\$29,963	\$46,879
Commercial	1,020	2,174	6,545	10,561	16,635	33,597
Total	10,222	15,217	24,705	32,345	46,597	80,476
<b>TOTAL- Lynn</b>	<b>\$18,680<sup>1</sup></b>	<b>\$37,817<sup>1</sup></b>	<b>\$70,750<sup>1</sup></b>	<b>\$113,169</b>	<b>\$217,712</b>	<b>\$496,555</b>
Saugus + Revere						
<sup>1</sup> Partial recurring for Saugus						

**Annual Losses**

As mentioned previously recurring losses relate the dollar value of flood damage to specific flood depths. For the purpose of determining the severity of potential flooding in each damage reach the statistical concept of "expected value" is employed. Annual losses for each zone are simply the integration of two sets of data: (i) recurring losses displayed in one-foot increments of flood depth from the start of damage to the elevation of the SPN and (ii) the estimated annual percent chance that flood levels will reach each elevation for which recurring losses were estimated. Simply, the probability of reaching a specific flood stage during any given year is multiplied by the corresponding dollar value of damage. The summation of these expected values results in potential annual losses. The effectiveness of each flood reduction plan is measured by the extent to which it reduces annual losses. Annual losses by zone for each community in the floodplain are shown in Tables 51 through 53.

TABLE 51  
AVERAGE ANNUAL LOSSES  
(\$1000 FEB 1988)  
LYNN

Zone	Commercial/Industrial	Residential	Total
1	836	603	\$1,439
2	1,194	0	1,194
3	299	38	337
Total	2,329	641	<u>\$2,970</u>

TABLE 52  
AVERAGE ANNUAL LOSSES  
(\$1000 FEB 1988)  
SAUGUS

Zone	Commercial/Industrial	Residential	Total
1	\$8	\$158	\$166
1c	49	0	49
2	62	496	558
3	13	297	310
3a	2	227	229
Total-W/3	\$132	\$951	\$1,083
Total-W/3a	\$121	\$881	\$1,002

TABLE 53  
AVERAGE ANNUAL LOSSES  
(\$1000 Feb 1988)  
REVERE

Zone	Commercial/Industrial	Residential	Total
1	\$47	\$176	\$223
2a	101	0	101
2b	122	433	555
3a,b,c	136	35	171
4a	49	477	526
4b	0	17	17
4c	86	48	134
5a,c,d	123	539	662
5b	0	22	22
6	2	39	41
7a	32	213	245
7b	2	450	452
7c	21	585	606
7d	4	208	212
Total	\$725	\$3,242	\$3,967

#### Emergency Costs

Emergency costs are defined as costs which result from emergency activities prior to, during, and after a flood. Emergency costs include expenses for flood emergency centers, communication facilities not otherwise needed, temporary evacuation assistance, flood fighting materials and personnel, additional police and fire protection, and public clean-up.

Available data on experienced emergency costs for Revere and Lynn consist primarily of information obtained after the February 1978 flood. During this storm a state of emergency was declared in Massachusetts and the President of the United States declared Massachusetts a "major disaster area". The Federal Disaster Assistance Administration (FDAA) opened a Disaster Assistance Center in Revere. Also, Follow-up Assistance on Service Teams (FASTS) were organized. "Project Concern" a six-month crisis counseling service was established by the Massachusetts Department of Mental Health. The American Red Cross, the Massachusetts National Guard and regular U.S. Army also provided assistance. A list of agencies involved in emergency operations during the 1978 storm and the subsequent rehabilitation is provided in Table 54.

Activities associated with the 1978 flood are documented more fully in the February 1979 Corps report, "Blizzard of '78, Coastal Storm Damage Study." Although the aim of that study was to allocate flood costs and expenses to the community in which losses occurred, in many instances data would be summarized at the State or, in some cases, the city level. The summarized information shows that total public and private losses and expenses amount to over

\$257,000,000 for the Commonwealth of Massachusetts. The comparable figure for the city of Revere is \$16,140,000. Costs in Revere are, therefore, estimated to account for approximately 6% of all State flood costs.

The figures discussed thus far refer to all costs and losses, not just emergency costs. In many instances it is difficult to differentiate between emergency costs and funds derived from regular operating budgets. Investigation reveals that best estimate of true emergency costs is the list of funds made available from the President's Disaster Relief Fund. Moneys made available to the Commonwealth of Massachusetts from this fund are as follows.

Temporary Housing	\$12,500,000	
Disaster Unemployment Assistance	\$ 300,000	
Individual and Family Grants	\$ 4,000,000	
Crisis Intervention	\$ 461,526	
FCO Mission Assignment	\$ 50,000	
Public Assistance	<u>\$20,691,695</u>	
Total	\$38,003,221	(1978 P.L.)

TABLE 54  
Emergency Organizations Involved  
In Study Area, 1978

1. Housing and Urban Development (HUD)
  - Temporary Housing
  - Federal Insurance Administration
  - Minimal Repair Program
2. Small Business Administration (SBA)
  - Homes and Personal Loans
  - Business Loans
3. Department of Labor (DOL)
  - Disaster Unemployment Insurance
4. Department of Agriculture (DOA)
  - Food and Nutrition Service (Food Stamps)
  - Farmers Home Administration
5. Federal Disaster Assistance Administration (FDAA)
6. Internal Revenue Service (IRS)
  - Casualty Loss
7. Community Services Administration (CSAO)
  - Grants to Local Communities
  - Action Agencies for Food and Fuel
8. Health, Education and Welfare (HEW) - Offices on
  - Aging Grants for Special Needs of Elderly and Education

9. Federal Highway Administration (FHA)  
Federal Aids to Road and Highways
10. U.S. Army Corps of Engineers (CE)  
Operations and Maintenance  
Emergency Rehabilitation of Flood Projects
11. U.S. Army, Massachusetts  
Massachusetts National Guard
12. U.S. Economic Development Administration  
Massachusetts Disaster Recovery Team  
(Operation and Coordination)
13. Mission Assignments, Massachusetts (Reimbursed by FDAA)  
U.S. Army Corps of Engineers  
U.S. Army New England Division, Corps of Engineers  
Environmental Protection Agency  
Federal Aviation Agency  
Federal Highway Administration  
General Services Administration
14. U.S. Coast Guard, Massachusetts  
Minor Aids to Navigation

In order to estimate the portion of these emergency costs which were expended in the study area, several assumptions and procedures were required. Because NED damage surveys already include expenses for temporary housing this item was eliminated from the fund total, resulting in a new total of approximately \$25,500,000. Next, because it had been determined that Revere accounted for 6% of total State flood costs, it was assumed that Revere accounted for 6% of State emergency costs. This resulted in an estimate of \$1,500,000 in emergency costs for Revere during the 1978 flood.

Information from several damage surveys of Revere indicate that Revere Backshore generally suffers approximately 45% of all flood losses in the city. The \$1,500,000 Revere total, was, therefore, multiplied by 0.45 to obtain estimated emergency costs of \$675,000 for the study area in 1978. Updated to February 1988, this cost is approximately \$1,034,000. It should be noted that this figure may be somewhat conservative since no effort has been made to quantify the opportunity costs of the flood emergency (e.g., its value of time lost to individual due to traffic diversion, time spent applying for disaster relief, loans, etc.)

Average annual emergency costs were computed by relating stage-emergency cost data to stage-frequency data using the 1978 flood as a base. Emergency cost for each of the 13 damage zones were based on emergency costs and recurring losses holds true for other flood events allow the development of emergency cost-frequency data for each of the 13 damage zones. Expected

annual emergency costs were computed using standard frequency integration techniques. Annual emergency costs were estimated to be \$195,000 for Revere Backshore.

Similar assumptions were made to develop emergency costs for Lynn and Point of Pines. It was determined that Lynn accounted for approximately four percent of total state emergency costs. This resulted in an estimate of \$1,020,000 in emergency costs for Lynn during the 1978 flood. Additionally, it is estimated that the study area accounts for ninety percent of total flooding in Lynn. This would result in \$918,000 in estimated emergency cost or \$1,496,000 at the February 1988 price level. Annual emergency costs were estimated in combination with annual inundation losses for the city of Lynn. As emergency costs were not reported for Saugus, emergency costs were not developed for this community.

#### Floodproofing Costs

#### Flood Insurance Overhead

A national cost for flood insurance program is its administrative costs. The cost of servicing flood insurance policies is determined based upon the average cost per policy, including agent commission, and the cost of servicing and adjusting claims. This benefit is considered for those structures which have obtained flood insurance. In November 1988 there were 892 flood insurance policies in effect in Revere, Saugus and Lynn. It was assumed most of these policies were held by the property owners within the 100-year coastal flood plain.

Approximately 75% of Revere's insured property owners are estimated to be within the study area in Revere, 100% in Saugus and 75% in Lynn. It is therefore estimated that 698 policies are in effect within the study area. The resulting 698 policies would have an administrative overhead cost of \$85 per policy. The average annual benefit for the structural plans is equal to the annual cost of the administrative overhead, or approximately \$59,300.

#### Future Flood Losses

Under the without project condition, future flood damages are expected to increase. The additional damages are in the form of further commercial development of the flood plain and increases in the value of residential contents.

#### Residential and Commercial Development

Planned development in Lynn includes Harborside Landing which consists of 2 27-story towers, 2 16-story high rises, a public marina and parking area. This development should be impacted by flooding. Because the city of Lynn is in the regular phase of the National Flood Insurance Program, future flood plain development must be floodproofed to the 100-year event. Future flood damage to the 452 condo units high rise development was estimated for events in excess of the 100-year flood. Another potential development site is Lynn

South Harbor which consists of office buildings, retail shops, condominiums, hotel, restaurant marina and parking area. Additional future losses are expected to be \$113,000 annually.

There are several residential high rise developments and a parking garage with retail space planned for the vacant land along Revere Beach Boulevard. Discussions with local officials indicated that construction of these proposed projects is reasonably certain and will be completed by the year 1994 which is the base year of the proposed Federal project. Because the city of Revere is in the regular phase of the National Flood Insurance Program, future commercial flood plain development must be floodproofed to the 100-year event. Future flood damage to the proposed garage/retail building and the 1800 unit residential high rise development was estimated for events in excess of the 100-year flood. Additional future commercial flood losses are expected to be \$27,000 annually. The development is expected to be completed by the 1989.

Future residential and commercial development in Saugus is expected to result in future annual losses of \$7,000.

#### Increased Contents Value (affluence)

As real per capita income increases, the real value of residential contents will increase. As contents value grows, the potential dollar amount of damage grows. The OBERS (Bureau of Economic Analysis, Department of Commerce) regional growth rate for per capita income is used as the basis for increasing the real value of residential contents in the future. OBERS information (1985) shows that per capita income in the Boston NECMA (New England County Metropolitan Area) is expected to increase as shown in Table 55.

TABLE 55  
PER CAPITA INCOME BOSTON NECMA  
(1972 DOLLARS)

Year	Annual Compound Per Capita Income	Growth	Rate
1983	6693	1983-1990:	.022779
1990	7836	1990-1995:	.014480
1995	8420	1995-2000:	.011559
2000	9372	2000-2005:	.009980
2005	9372	2005-2015:	.008492
2015	10,199	2105-2035:	.008549
2035	12,092	-----	

Field visits to the study area indicated that the houses were in good condition. It was assumed that the neighborhoods would remain stable and that homeowners would increase the value of the contents in their homes. Review of residential damage survey information indicated that the existing values of residential contents was approximately 51% of the value of the structure. It is anticipated that the value of the contents will increase to 75% of the

value of the structure. The 75% limit is based on the Principles and Guidelines. At the rates of growth shown in Table 55, the 75% limit will be reached 15 years into the project life (2010). The increasing value of residential contents, expressed in terms of annual losses, are: Lynn - \$30,000, Saugus - \$72,000 and Revere - \$138,000. This is compared with the following annual contents damage under existing conditions: Lynn - 63,000, Saugus - 149,000, and Revere \$287,000.

#### Sea Level Rise

Anticipated sea level rise will raise the stage frequency curve by approximately one foot over the hundred year project life. One foot is the historical rate of sea level rise over the previous one hundred years. It is estimated that historical sea level rise will increase expected property damage by \$1,425,000, or approximately 17 percent, in the study area.

#### Damage to Shorefront Structures

Damages to riprap, walls, dunes, embankment, dikes and piers were estimated over the one hundred year project life with and without the project in place. Damage estimates along 30 miles of shorefront bordering Lynn Harbor, Point of Pines and the Saugus and Pines River estuary were made for NED by Vollmer Associates and in part by NED for this investigation explained in the Plan Formulation Appendix. Damages include replacement costs and annual maintenance cost for these shorefront structures. Average annual damages are estimated at \$2,574,000 over the project life.

#### Summary of Annual Losses

Flood losses under the without project condition are presented in Table 56.

TABLE 56  
ANNUAL FLOOD LOSSES  
WITHOUT PROJECT  
(\$1,000 and Feb 1988 Price Level)

	<u>LYNN</u>	<u>SAUGUS</u>	<u>REVERE</u>	<u>TOTAL</u>
Flood Damages (Properties)				
Residential	\$641	\$950	\$3,242	4,833
Comm/Ind/Public	2,329	132	725	3,186
Emergency Costs	*	N.D.	195	195
Flood Ins. Overhead	4	10	45	59
Future Flood Damage (development)	113	7	27	147
(Sea Level Rise)	490	241	694	1,425
(Continued)				

Increased Value of Residential Contents	30	72	138	240
Damages to Shorefront Structures	755	695	1,124	2,574
TOTAL	4,362	2,107	6,190	12,659

\* - estimated in conjunction with annual inundation losses

N.D. - not determined for Saugus

### Plans of Improvement

There are two major types of plans to reduce flooding damages - structural and nonstructural. Structural measures are physical measures which act directly on tidal waters to change their direction, area of inundation, volume, stage or timing to reduce flood damages. Examples include floodwalls, levees, dams, channel alterations and high flow diversions and spillways. Nonstructural measures are actions designed to reduce or avoid flood damages. Nonstructural measures fall into three categories: (1) measures that permanently modify damage susceptibility of existing structures, (2) measures which manage future development and (3) flood preparedness plans. Damage susceptibility of structures is modified by either flood proofing or removing them from the floodplain. Flood-proofing measures protect the structure and its contents by excluding water through the use of either closures and seals, raising the structure or using perimeter barriers. Managing future development reduces flood losses by either discouraging potential activities from locating in the floodplain or taking measures that recognize the flood hazard for those structures that would locate in the floodplain. Flood preparedness plans include measures that are taken immediately before, during or immediately after a flood in an attempt to reduce losses which would otherwise result. Specific actions that might be taken are (1) emergency evacuation of people and property, (2) floodfighting (3) emergency relief, (4) repair of public utilities and facilities and (5) cleanup after the flood waters recede.

There are three plans or options under consideration to protect the study area. Two of the plans are structural and one plan is nonstructural. Plan, 1 is a series of local protection plans (LPP's) to protect each of the flooded areas. Earth dikes or concrete walls would be employed to prevent coastal waters from flowing over the shore front and riverbanks. The structural alignments under consideration are: (1) Revere Beach Backshore - about three miles of walls and dikes along the banks of the Pines River and for the Revere Beach parkland behind the beach.

- (2) Northgate - about one mile bordering the Pines River marsh.
- (3) Town Line Brook - about one-half mile bordering the Pines River marsh.
- (4) East Saugus - about three miles bordering the Pines River marsh and Saugus River.
- (5) Lynn - about five miles bordering Lynn Harbor, and the Saugus River.

Plan 2 is nonstructural and would reduce the vulnerability to flooding through flood preparedness plans and floodproofing of buildings. This plan

includes a flood warning system and floodproofing measures such as raising first floors, providing water tight enclosures for utilities and sealing windows and doors with waterproofed closures.

Plan 3 is structural and calls for a tidal floodgate to protect all flood prone areas under consideration. Physical features include a concrete wall or earth and stone faced dike across a river, a navigation gate and flushing gates to maintain both navigation and natural flushing of the rivers and marshlands. The gates would remain open until the threat of a flood. Five alternative floodgate alignments under consideration include positioning the structure at the mouth of the Saugus River. Under this plan the marshes in the Saugus and Pines River estuaries would be preserved as natural storage areas for interior runoff. Shorefront protection is also included along Revere Beach, Lynn Harbor and Point of Pines.

#### Economic Benefit Estimation

The three types of benefits are (1) inundation reduction, (2) intensification and (3) location. Inundation reduction is a flood control benefit to those activities whose location decisions are unaffected by a proposed plan. It is the value of flood losses prevented to those activities which would use the floodplain even without the proposed plan. An intensification benefit arises when a plan induces an activity to modify its operation in the flood plain. The benefit is measured as the increase in market value of land or changes in direct income. A location benefit is the change in net income to those activities whose decisions as to where to locate are affected by the proposed plan. This benefit may be measured by the market value of the floodplain land and possibly adjacent land, if the plan creates open space.

Inundation reduction benefits include reduction of primary flood damage, floodproofing costs and flood insurance overhead. Primary flood damages include physical damages, income loss and emergency costs. Physical damages refer to buildings and contents including furnishings, equipment, materials and products, and loss of roads, sewers, bridges, power lines, etc.

Income loss refers to loss of wages or net profits to business over and above physical flood damages. Prevention of income loss results in a benefit only to the extent that such loss cannot be compensated for by postponement of an activity or transfer of the activity to other establishments outside of the floodplain. Emergency costs include the costs of evacuation flood fighting, disaster relief, and increased costs of fire and police activity. Primary flood losses are calculated for both present and future conditions.

#### Inundation Reduction - Primary Flood Losses

Primary flood losses for 500-year level of protection under existing conditions for Revere, Saugus and Lynn are shown in Tables 57 through Table 66. Annual benefit is defined as the difference in expected annual average damage with and without a project.

**TABLE 57A**  
**REDUCTION OF PRIMARY FLOOD DAMAGES,**  
**EXISTING CONDITIONS, REVERE BACKSHORE**  
**PLAN 1, LLP 500 YEAR LEVEL**  
**OF PROTECTION**

Zone	Expected Annual Damage without Project (\$1000 Feb 1988)	Expected Annual Damage with Project (\$1000 Feb 1988)	Annual Benefits (\$1000 Feb 1988)
1R	176	111	65
1C	47	19	28
1*	223	130	93
2A-R	0	0	0
2A-C	101	27	74
2A	101	27	74
2B-R	423	179	254
2B-C	122	20	102
2B	555	199	356
3R	35	31	4
3C	136	125	11
3	171	156	15
4A-R	477	185	292
4A-C	49	17	32
4A	526	202	324
4B-R	17	8	9
4B-C	0	0	0
4B	17	8	9
4C-R	48	40	8
4C-C	86	28	58
4C	134	68	66
5A-R	539	15	524
5A-C	123	26	97
5A	662	41	621
5B-R	22	4	18
5B-C	0	0	0
5B	22	4	18
Subtotal - R	1,747	573	1,174
Subtotal - C	664	262	402
Total	2,411	835	1,576
* Benefit in Zone 1 is only for 100 year level of protection.			

R - Residential

C - Commercial, industrial, public including emergency costs

Note: Benefits determined by taking 50% of benefits in freeboard range.

TABLE 57B  
REDUCTION OF PRIMARY FLOOD DAMAGES  
EXISTING CONDITIONS, REVERE NORTHGATE  
PLAN 1, LPP 500 YEAR LEVEL  
OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb 1988)	Expected Annual Damage with Project (\$1000 Feb 1988)	Annual Benefits (\$1000 Feb 1988)
1R	39	4	35
1C	2	0	2
Total	41	4	37

Note: Benefit determined using 50 percent of benefits in freeboard range.

Note: Zone 1 same as Zone 6, Table 53

TABLE 57C  
REDUCTION OF PRIMARY FLOOD DAMAGES  
EXISTING CONDITIONS, REVERE POINT OF PINES  
LPP 500 YEAR LEVEL OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb 1988)	Expected Annual Damage with Project (\$1000 Feb 1988)	Annual Benefits (\$1000 Feb 1988)
1R	213	8	205
1C	32	21	11
1	245	29	216
2R	450	4	446
2C	2	0	2
2	452	4	448
3R	585	75	510
3C	21	5	16
3	606	80	526
4R	208	2	206
4C	4	0	4
4	212	2	210
Subtotal-R	1,456	89	1,367
Subtotal-C	59	26	33
Total	1,515	115	1,400

Note: Zones 1 through 4 same as zones 7a through 7d, Table 53.

TABLE 58  
REDUCTION OF PRIMARY FLOOD DAMAGES  
EXISTING CONDITIONS, SAUGUS  
PLAN 1 LPP, 500-YEAR LEVEL  
OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb 1988)	Expected Annual Damage with Project (\$1000 Feb 1988)	Annual Benefits (\$1000 Feb 1988)
1R	158	5	153
1C	8	7	1
1	166	12	154
1C-R	0	0	0
1C-C	49	41	8
1C	49	41	8
2R	496	29	467
2C	62	8	54
2	558	37	521
3R	297	28	269
3C	13	1	12
3	310	29	281
3A-R	227	15	212
3A-C	2	0	2
3A	229	15	214
Total-W/3	1,083	119	964
Total-W/3A	1,002	105	897

R - Residential

C - Commercial, industrial, public including emergency costs

Note: Benefit determined by taking 50% of benefits in freeboard range.

TABLE 59  
REDUCTION OF PRIMARY FLOOD DAMAGES,  
EXISTING CONDITIONS, LYNN  
PLAN 1 LPP, 500-YEAR LEVEL  
OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb 1988)	Expected Annual Damage with Project (\$1000 Feb 1988)	Annual Benefits (\$1000 Feb 1988)
1R	603	66	537
1C	836	86	750
1	1,439	152	1,287
2	1,194	193	1,001
3R	38	8	30
3C	299	42	257
3	337	50	287
Total	2,970	395	2,575

R - Residential

C - Commercial, industrial, public including emergency costs

Note: Benefit determined using 50 percent of benefits in freeboard range.

TABLE 60  
REDUCTION OF PRIMARY FLOOD DAMAGES,  
EXISTING CONDITIONS, REVERE, SAUGUS, LYNN  
PLAN 2, NONSTRUCTURAL 100-YEAR LEVEL  
OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb 1988)	Expected Annual Damage with Project (\$1000 Feb 1988)	Annual Benefits (\$1000 Feb 1988)
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NOTE: See Plan Formulation Appendix for nonstructural analysis.

TABLE 61  
REDUCTION OF PRIMARY FLOOD DAMAGES,  
EXISTING CONDITIONS, REVERE  
PLAN 3, FLOODGATE, 500-YEAR LEVEL  
OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb. 1988)	Expected Annual Damage with Project (\$1000 Feb. 1988)	Annual Benefits (\$1000 Feb. 1988)
1-R	176	111	65
1-C	47	19	28
1	223	130	93
2A-R	0	0	0
2A-C	101	27	74
2A	101	27	74
2B-R	433	179	254
2B-C	122	20	102
2B	555	199	356
3A-R	35	31	4
3A-C	136	125	11
3A	171	156	15
4A-R	477	185	292
4A-C	49	17	32
4A	526	202	324
4B-R	17	8	9
4B-C	0	0	0
4B	17	8	9
4C-R	48	40	8
4C-C	86	28	58
4C	134	68	66
5A-R	539	15	524
5A-C	123	26	97
5A	662	41	621
5B-R	22	4	18
5B-C	0	0	0
5B	22	4	18
6-R	39	3	36
6-C	2	0	2
6	41	3	38

TABLE 61 CONT'D

7A-R	213	7	206
7A-C	32	21	11
7A	245	28	217
7B-R	450	4	446
7B-C	2	0	2
7B	452	4	448
7C-R	585	32	553
7C-C	21	5	16
7C	606	37	569
7D-R	208	2	206
7D-C	4	0	4
7D	212	2	210
Subtotal-R	3,242	621	2,621
Subtotal-C	725	288	437
Total	3,967	909	3,058

R - Residential

C - Commercial, industrial, public including emergency costs

Note: Fifty percent of benefits are calculated in the freeboard range, except for Point of Pines.

TABLE 62  
REDUCTION OF PRIMARY FLOOD DAMAGES  
EXISTING CONDITIONS, SAUGUS  
PLAN 3, FLOODGATE, 500-YEAR LEVEL  
OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb. 1988)	Expected Annual Damage with Project (\$1000 Feb. 1988)	Annual Benefits (\$1000 Feb 1988)
1R	158	6	152
1C	8	0	8
1	166	6	160
1C-R	0	0	0
1C-C	49	11	38
1C	49	11	38
2R	496	15	481
2C	62	6	56
2	558	21	537
3R	297	20	277
3C	13	3	10
3	310	23	287
3A-R	227	13	214
3A-C	2	0	2
3A	229	13	216
Total-W/ZN.3	1,083	61	1,022
Total-W/ZN.3A	1,002	51	951

R - Residential  
C - Commercial

Note: Fifty percent of benefits are calculated in freeboard range.

TABLE 63  
REDUCTION OF PRIMARY FLOOD DAMAGES  
EXISTING CONDITIONS, LYNN  
PLAN 3, FLOODGATE, 500-YEAR LEVEL  
OF PROTECTION

Zone	Expected Annual Damage without Project (\$1000 Feb. 1988)	Expected Annual Damage with Project (\$1000 Feb. 1988)	Annual Benefits (\$1000 Feb. 1988)
1R	603	61	542
1C	836	78	758
1	1,439	139	1,300
2	1,194	162	1,032
3R	38	5	33
3C	299	14	285
3	337	19	318
Total	2,970	320	2,650

R - Residential

C - Commercial, industrial, public including emergency costs

Notes: Fifty percent of benefits are calculated in freeboard range.

TABLE 64  
 PLAN 1 BENEFIT  
 500-YEAR PROTECTION  
 (\$ 1,000 Feb. 1988)

Location	Expected Annual Flood Damages Without Project	Expected Annual Flood Damages With Project	Benefit
Lynn	2,970	395	2,575
Saugus	1,083	119	964
Revere	3967	954	3013
Backshore	2411	835	1576
Northgate	41	4	37
Point of Pines	1515	115	1400
Total	8020	1468	6552

TABLE 65  
PLAN 2 BENEFITS  
100-YEAR PROTECTION

Location	Expected Annual Flood Damages Without Project	Expected Annual Flood Damages With Project	Benefit
Lynn			
Saugus	NOTE: See Plan Formulation Appendix		
Revere			
Total			

TABLE 66  
PLAN 3 BENEFITS  
500-YEAR PROTECTION  
(\$1,000 Feb. 1988)

Location	Expected Annual Flood Damages Without Project	Expected Annual Flood Damages With Project	Benefit
Lynn	2,970	320	2,650
Saugus	1,083	61	1,022
Revere	3,967	909	3,058
Total	8,020	1,290	6,730

### Damage Prevention to Shorefront Structures

In addition to reducing flood damages to residential, commercial, industrial and public structures and activities in the study area, the two structural plans (Plans 1 and 3) will also prevent damages to existing shorefront structures such as seawalls, bulkheads and piers. These benefits are found in Table 67 below.

TABLE 67  
DAMAGE PREVENTION TO SHOREFRONT STRUCTURES  
(Applies to 100, 500 and SPN Protection)  
(\$1,000 Feb. 88)

	Plan 1 (LPP's)	Plan 3 (Regional Plan)
Lynn	277	390
Revere		
Backshore	54	225
Point of Pines	103	103
Saugus	15	244
Piers	0	696
TOTAL	449	1,658

### Location Benefit

Location benefits are the difference between aggregate net incomes which result when an activity uses the floodplain with a plan but not without it. The difference between estimated market value of the floodplain land with and without the plan was taken as an estimate of the present value of the difference between aggregate net incomes.

Within the Revere Beach Backshore study area there are approximately 45 acres for undeveloped floodplain land. The majority of this land is zoned for residential/high rise development. Its present market value is approximately \$500,000/acre. Due to the high per acre value of land in Revere it was felt that land values would not increase any further with the project. Traditionally, location benefit is associated with change in land value brought about by change in land use in the with project condition. Within Saugus and Lynn, there are 500<sup>1</sup> and 67 acres, respectively, of undeveloped flood plain land. Location benefit was not identified in these areas.

### Intensification Benefit

This benefit category occurs when land use is the same with and without the project, but in the with project condition the method of operation is modified. The increased net income of the activity is a project benefit. There were no intensification identified in the study area.

### Recreation Benefit

#### Project Description

The proposed flood protection embankment between Revere Beach Boulevard and Ocean Avenue from Shirley Avenue to Revere Street is being considered for development as a parkland on a cost-sharing basis with the Metropolitan District Commission (MDC). The recreation features for the parkland are described in the MDC's 1978 Master Plan and 1983 Master Plan Summary.

After completion of the flood reduction like feature of the plan which jointly serves as parkland, additional features would be added by the MDC. Major features of the proposed linear park are a network of curvilinear pathways intersecting the major entryways from the two MBTA stations and site amenities including benches, drinking fountains, trash receptacles, lighting, graphic panels of past beach scenes, play equipment, game tables, pergolas, etc. The ambience is to be "pleasantly festive" as intended by Charles Eliot in 1895.

- 1) includes marsh

The flood reduction plan includes minimum landscaping in accordance with good engineering principles. It is anticipated that this plan would have similar recreation benefits as the proposed MDC park.

To accommodate the park and provide proper flood protection and drainage, the dike would include several feet of earth to fill the void between the dike and the top of the secondary seawall. No trees, only shrubs and lawn grass could be planted within about 15 feet of the dike structure. Revere Beach Boulevard would be ramped immediately north of the Beach Street Pavilion to the Design Stillwater Level with provision for closure in the freeboard. About 200 feet of the Revere Beach Seawall would be rebuilt to handle the load of the ramp. The "Park Dike" would tie into the ramp. A ramp or raised intersection may be required at the Revere Street intersection depending of the level of protection required. The "Park Dike" would be tied into the existing retaining wall of the Shawmut Street ramp adjacent to the north side of the Police Station and a new retaining wall on the south side. Immediately following completion of the Corps flood control project contract, the MDC would schedule completion of the landscaping, lighting, walkways, and other recreation features under a state contract.

The dimensions of the proposed strip park are approximately 3,420 feet by 130 feet. Being long and narrow and graded on the ocean side from the top of the sitting wall toward the top of the dike at a slope of approximately 1:14, the proposed park would accommodate mainly passive recreation activities. In preparation for carrying out the Master Plan initiatives, the MDC acquired the 13 acres of land for the proposed dike and began to demolish buildings on the site in 1977.

The MDC has plans to independently install the secondary sitting wall and drainage systems between Beach Street and Revere Street prior to the construction of the cost-shared "Park Dike". Furthermore, the MDC Master Plan calls for the Commission to improve an existing ballfield and play equipment at nearby Sullivan Park; to narrow Revere Beach Boulevard and to build a wooden boardwalk between it and the seawall; and to span a raised pedestrian walkway from the Wonderland public transit station across Ocean Avenue to Revere Beach. The attractiveness of Revere Beach Reservation will be further enhanced by the MDC's ongoing restoration of the historic pavilions and bandstands and by the reconstruction of sanitariums and bathhouses.

#### Regional Demand for General Recreation

Proposed traffic and drainage improvements and beach restoration are anticipated to attract and accommodate more recreation users to the Revere Beach Reservation in the future. Even in the Reservation's present deteriorated condition, the relatively good water quality of Revere Beach in comparison to South Shore metropolitan Boston beaches accounts for users' tolerance of typically high densities and an increase in the Blue Line's mass transit commuter rail ridership in the summer months. According to the MDC, attendance at its South Shore beaches has declined due to the poor water quality of the inner harbor.

The Massachusetts State Comprehensive Outdoor Recreation Plan (SCORP) for 1976 indicates excess demand for general recreation activity days in Eastern Massachusetts. The excess demand for swimming, picnicking, hiking and bicycling activity days was derived from "annual capacity activity days" and "capacity as percent of estimated demand in 1975" figures. The excess demand for swimming (other than in pool) was 3.2 million activity days; for picnicking it was 10 million activity days; for hiking it was 9.4 million activity days; and for bicycling it was 22.3 million activity days.

Inside Route 128 there are very few public park owner agencies beside the MDC and City Parks. Use levels at the MDC's Castle Island waterfront park exceed those at the proposed Revere Beach parkland. Fort Independence and the surrounding park is the primary South Shore area where daily 5,000 to 10,000 people circulate through landscaped sidewalks and use picnic tables.

Nantasket Beach and amusement park in Hull is similar to what Revere Beach used to be fifteen years ago but is undergoing renovation. Nantasket Beach is not a suitable alternative for North Shore residents because it is not accessible by subway from Boston.

### Methodology

Policy guidance for evaluation of recreational facilities for structural flood reduction plans require that the costs of recreational development may not increase the Federal project cost by more than 10 percent. In addition, the structural flood improvement plans and the recreational components must each separately achieve benefit-cost ratios of unity or greater in order to be considered economically feasible.

The three methods used in evaluating water project recreation development benefits are: (1) travel cost, (2) contingent value and (3) unit day value. The travel cost method is not used in this study as most of the park and beach goers reside in the vicinity of the Reservation. Nash-Vigier, Inc. conducted a survey in 1970 of the origin and mode of transportation; they found that 26.7 per cent of Revere Beach users were Revere residents and that 20.8 percent were from contiguous communities (Chelsea, Lynn, Malden, Melrose and Winthrop). Furthermore, 12.4 percent of visitors were from Boston proper and 15.1 percent from Boston's inner suburbs, all of which are served by the MBTA. Only 13.2 percent of visitors' trips originated outside of the Boston Metropolitan Area. Thus, there would not be enough variation in the independent variable to estimate a demand function.

The contingent value method obtains estimates in NED benefits directly by asking individuals about their willingness to pay. This method is limited to the requirement of having all surveys forms subject to the clearance procedures of OMB. Since a list of approved survey questions needed to apply this technique to a site specific general recreation project does not currently exist, the amount of time required to obtain specific survey authority precludes its use. Additionally, this method is very expensive and would make study costs too high a proportion of total project costs.

The unit day value method was chosen based on its simplicity, ease of application and its ability to measure increases in benefits at the study site. The improvements at the site affect less than 750,000 user days which is a criterion of use. Additionally, the study cost of this approach is more reasonable when compared to overall project cost.

Recreation benefits are computed using the unit day value method described in WRC's Principles and Guidelines. Park attendance is considered to be "generalized recreation other than hunting and fishing." Point values from Table 69 were assigned to the Dike Parkland for the criteria listed in Table 68. Point values were assigned for the with project condition, and are converted to dollar values as shown on Table 70.

Table 70  
Recreational Value

Criteria	Points
Recreation Experience	9
Availability of Opportunity	3
Carrying Capacity	9
Accessibility	12
Environmental Quality	9
Total	42
Unit Day Value (FY 88)	\$3.43

While usage of the park is expected to continue throughout the year, only the prime summer season is considered in this benefits analysis. The annual demand is broken down to a daily demand assuming 24 peak days and 66 average days in a prime season which extends from late June to early September. Each of these periods is reduced by 25 percent to account for inclement weather, resulting in a peak season of 18 days and an average season of 50 days.

Park visitation was estimated from actual attendance in the reaches of Revere Beach Reservation corresponding to the extent of the park. People "sitting on seawall or sidewalk", "walking on sidewalk or road" and "on parkland (undeveloped grassland)" were considered to be potential users of a developed park. Attendance records indicate that demand on peak days is double the demand on average days. With a turnover of 2.5 the peak day attendance is 2,815 and the average day attendance is 1,407 (Voilmer Associates, "Recreation Projection and Surveys for Revere Beach Reservation." Boston, Mass., submitted to U.S. Army Corps of Engineers, New England Div., April 1986. Attachment 1: Revere Beach Count Data, Sundays in Summer 1985, Metropolitan District Commission). The annual demand for park activity days is calculated in Table 71.

Table 68 -Guidelines for Assigning Points For General Recreation

Criteria	Judgment factors				
(a) Recreation experience <sup>1</sup>	Two general activities <sup>2</sup>	Several general activities	Several general activities; one high quality value activity <sup>3</sup>	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Total points: 30 Point value:	0-4	5-10	11-16	17-23	24-30
(b) Availability of opportunity <sup>4</sup>	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total points: 18 Point value:	0-3	4-6	7-10	11-14	15-18
(c) Carrying capacity <sup>5</sup>	Minimum facility development for public health and safety	Basic facilities to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total points: 14 Point value:	0-2	3-5	6-8	9-11	12-14
(d) Accessibility	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Total points: 18 Point value:	0-3	4-6	7-10	11-14	15-18
(e) Environmental quality	Low esthetic factors <sup>6</sup> exist that significantly lower quality <sup>7</sup>	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total points: 20 Point value:	0-2	3-6	7-10	11-15	16-20

<sup>1</sup> Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.<sup>2</sup> General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.<sup>3</sup> High quality value activities include those that are not common to the region and/or Nation and that are usually of high quality.<sup>4</sup> Likelihood of success at fishing and hunting.<sup>5</sup> Value should be adjusted for overuse.<sup>6</sup> Major esthetic qualities to be considered include geology and topography, water, and vegetation.<sup>7</sup> Factors to be considered to lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

-Guidelines for Assigning Points For Special Recreation

Criteria	Judgment factors				
(a) Recreation experience <sup>1</sup>	Heavy use or frequent crowding or other interference with use	Moderate use, other users evident and likely to interfere with use	Moderate use, some evidence of other users and occasional interference with use due to crowding	Usually little evidence of other users, rarely if ever crowded	Very low evidence of other users, never crowded
Total points: 30 Point value:	0-4	5-10	11-16	17-23	24-30
(b) Availability of opportunity <sup>2</sup>	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total points: 18					

TABLE 69

Revised Table VIII-3-1 (FY1988) Conversion of Points to Dollar Values

## POINT VALUES

Activity Categories	0	10	20	30	40	50	60	70	80	90	100
General Recreation (Points from Table VIII-3-2)	1.85	2.15	2.45	2.85	3.30	3.95	4.25	4.55	4.85	5.20	5.50
General Fishing & Hunting (Points from Table V.II-3-2)	2.70	3.00	3.25	3.55	3.90	4.30	4.65	5.00	5.25	5.40	5.45
Specialized Fishing & Hunting (Points from Table VIII-3-3)	12.80	13.15	13.45	13.80	14.15	15.45	16.75	18.05	19.40	20.70	22.00
Specialized Recreation Other than Fishing & Hunting (Points from Table VIII-3-3)	7.35	7.95	8.55	9.15	9.80	11.00	12.25	14.65	17.10	19.55	22.00

NOTE: See ER1105-2-40, Change 2, 9 Jul 83, pages A-67 &amp; A-68 for Table VIII-3-2 and VIII-3-3

Table 71  
Annual Demand for Park Activity Days  
Revere Beach Parkland

	People	X	Days	-	Activity Days/Year
Peak	2,815		18		50,670
Average	1,407		50		70,350
Total					121,020

Thus, the annual benefits are 121,020 activity days per year times the unit day value of \$3.43 or \$415,099.

Impact of Future Sea Level Rise

The historic rate of sea level rise over the past 100 years in the study area has been 1 foot. Assuming that this rate will continue over the next 100 years, additional annual losses and benefits based solely on sea level rise have been estimated and annualized for the study area. Losses and benefits by community are shown in Table 72.

TABLE 72  
IMPACT OF SEA LEVEL RISE  
ON FUTURE LOSSES AND BENEFITS  
(\$1,000 Feb 1988)

Location	Increase in Annual Losses	Increase in Benefits 500 Year Protection Plan 3
Lynn	\$490	\$318
Saugus	241	169
Revere	694	610
TOTAL	\$1,425	\$1,097

Summary of Benefits

Plan benefits and costs aggregated over the entire study area are presented in Table 73 for the 500 year level of protection. Benefits for other levels of protection are shown in the following tables.

TABLE 73  
FLOOD HAZARD REDUCTION  
BENEFITS AND COSTS  
500-YEAR LEVEL OF PROTECTION  
(\$1,000 Feb. 1988)

Benefits and Costs	Plan 1 (LPP's)	Plan 3 (Flood Gate) Alignment 2
Benefits:		
-Inundation Reduction	\$6,552	\$6,730
-Reduction of Damage to Shorefront Structures	449	1,660
-Emergency Costs	163	163
-Future Costs	0	78
-Future Development	125	128
-Affluence	239	243
-Reduced F.I. Overhead	59	59
-Sea Level Rise	1,084	1,097
-Recreation	415	415
Total Annual Benefits	\$9,086	\$10,573
Total Annual Costs	8,054	8,756
Benefit/Cost Ratio	1.1	1.2
Net Benefits	1,032	1,817

## Project Optimization

The optimization of Plan three is shown in Tables 74 and 75. Plan 3 has five different alignments. Alignments 1 and 2 provide protection to the Point of Pines section of Revere (Table 74), whereas alignments 3, 4, and 5 do not (Table 75). The project benefits for alignments 1 and 2 are identical and include Point of Pines. Benefits for alignments 3, 4 and 5 are also identical and exclude Point of Pines.

The optimization of Plan 1 is shown in Tables 76 through 81. As Plan 3 is actually five separate plans (5 different floodgate alignments), Plan 1 is also composed of 4 separate plans. Each LPP in Plan 1 is considered a separate plan. The four are: Revere Beach Backshore, Northgate, Saugus and Lynn. Benefits were developed for Point of Pines for purposes of comparison. Benefits were only calculated for the 500 year level of protection. Benefits for the 100 year and SPN levels of protection were developed based on the relationship of the 500 year Plan 1 benefits to the 500 year Plan 3 benefit. The relationship was then used to adjust 100 and SPN benefits of Plan 3 to obtain corresponding 100 and SPN benefits for Plan 1.

Table 82 compares the best Regional plan, (for Tables 74 and 75) from an economic viewpoint, with the best LLP plan (from Tables 76 through 81). Each LPP plan is optimized separately and the best LPP Plan is comprised of the separate plans that provide the largest net benefit. Table 82 displays the plan which maximizes net benefits and is therefore the NED Plan.

TABLE 74  
OPTIMIZATION OF PLAN 3 (REGIONAL PLAN)  
(FOR ALIGNMENTS 1 AND 2)  
(\$1,000 Feb. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	<u>100 Year</u>	<u>500 Year</u>	<u>SPN<sup>2</sup></u>
Benefits:			
-Inundation Reduction	6,152	\$6,730	6,968
-Reduction in Damage to Shorefront Structures	1,660	1,660	1,660
-Emergency Costs <sup>1</sup>	160	163	163
-Future Costs <sup>3</sup>	78	78	78
-Future Development	100	128	141
-Affluence	229	243	244
-Reduced F.I. Overhead	59	59	59
-Sea Level Rise	976	1,097	1,132
-Recreation	415	415	415
Total Annual Benefits	9,829	10,573	10,860
Total Annual Costs:			

Alignment 1	9,199	9,294	9,489
Alignment 2	8,671	8,756	8,942

**Benefit/Cost Ratio:**

Alignment 1	1.1	1.1	1.1
Alignment 2	1.1	1.2	1.2

**Net Benefits:**

Alignment 1	630	1,279	1,371
Alignment 2	1,158	1,817	1,918

1. Point of Pines and Revere Backshore only. In other areas reductions in emergency costs are included with inundation reduction.

2. SPN benefits not calculated for Point of Pines.

3. Reduce construction cost for Town Line LPP (State Project)

Note: Inundation reduction benefits for sea level rise are estimated only for the 500 year level of protection. Benefit for other levels of protection are based on their relationship to the 500 year level of protection for current conditions.

TABLE 75  
OPTIMIZATION OF PLAN 3 (REGIONAL PLAN)  
FOR ALIGNMENTS 3, 4, AND 5  
(\$1000 FEB. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	100 Year	500 Year	SPN
Benefits:			
-Inundation Reduction	4736	5285	5524
-Reduction in Damage to Shorefront Structures	1557	1557	1557
-Emergency Costs	41	42	42
-Future Costs (1)	78	78	78
-Future Development	100	128	141
-Affluence	90	94	95
-Reduced F.I. Overhead	51	51	51
-Sea Level Rise	824	912	947
-Recreation	415	415	415
Total Annual Benefits	7,892	8,562	8,850
Total Annual Costs:			
Alignment 3	9,143	9,237	9,430
Alignment 4	9,129	9,222	9,415
Alignment 5	9,607	9,707	9,911
Benefit/Cost Ratio:			
Alignment 3	0.8	0.9	0.9
Alignment 4	0.8	0.9	0.9
Alignment 5	0.8	0.8	0.8
Net Benefits:			
Alignment 3	-1,251	-675	-580
Alignment 4	-1,237	-660	-565
Alignment 5	-1,715	-1,145	-1,061

(1) Reduced construction cost for MDC's Town Line Brook LPP.

Note: Inundation reduction benefits for sea level rise are estimated only for the 500 year level of protection. Benefits for other levels of protection are based on their relationship to the 500 year level of protection for inundation reduction under existing conditions.

TABLE 76  
OPTIMIZATION OF PLAN 1  
LYNN  
(\$1000 FEB. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	<u>100 Year</u>	<u>500 Year</u>	<u>SPN</u>
Benefits:			
-Inundation Reduction	2255	2576	2768
-Reduction in Damage to Shorefront Structures	277	277	277
-Emergency Costs			
-Future Costs			
-Future Development	82	100	105
-Affluence	13	13	13
-Reduced F.I. Overhead	4	4	4
-Sea Level Rise	270	312	332
Total Annual Benefits	2901	3282	3499
Total Annual Costs	2941	3125	3356
Benefit/Cost Ratio	0.9	1.0	1.0
Net Benefits	-40	157	143

TABLE 77  
OPTIMIZATION OF PLAN 1  
SAUGUS  
(\$1000 FEB. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	100 Year	500 Year	SPN
Benefits:			
-Inundation Reduction	892	963	995
-Reduction in Damage to Shorefront Structures	15	15	15
-Emergency Costs			
-Future Costs			
-Future Development	6	7	7
-Affluence	53	53	54
-Reduced F.I. Overhead	10	10	10
-Sea Level Rise	147	161	164
Total Annual Benefits	1,123	1,209	1,245
Total Annual Costs	1,006	1,073	1,139
Benefit/Cost Ratio	1.1	1.1	1.0
Net Benefits	117	136	106

TABLE 78  
OPTIMIZATION OF LPP  
REVERE, POINT OF PINES  
(\$1000 FEB. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	<u>10 Year</u>	<u>100 Year</u>	<u>500 Year</u>
Benefits:			
-Inundation Reduction	1137	1367	1400
-Reduction in Damage to Shorefront Structures	103	103	103
-Emergency Costs	106	119	121
-Future Costs			
-Future Development			
-Affluence	131	146	149
-Reduced F.I. Overhead	8	8	8
-Sea Level Rise	0	160	186
Total Annual Benefits	1,485	1,903	1,967
Total Annual Costs	888	917	999
Benefit/Cost Ratio	1.7	2.1	2.0
Net Benefits	597	986	968

TABLE 79  
OPTIMIZATION OF PLAN 1  
REVERE (BACK SHORE)  
(\$1000 FEB. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	100 Year	500 Year	SPN
Benefits:			
-Inundation Reduction	1464	1576	1613
-Reduction in Damage to Shorefront Structures	54	54	54
-Emergency Costs	41	42	42
-Future Costs			
-Future Development	9	18	26
-Affluence	23	23	24
-Reduced F.I. Overhead	35	35	35
-Sea Level Rise	390	420	430
-Recreation	415	415	415
Total Annual Benefits	2,431	2,583	2,639
Total Annual Costs	2,356	2,620	2,926
Benefit/Cost Ratio	1.0	0.99	0.9
Net Benefits	75	-37	-287

TABLE 80  
OPTIMIZATION OF PLAN 1  
REVERE NORTHGATE  
(\$1000 FEB. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	100 Year	500 Year	SPN
Benefits:			
-Inundation Reduction	31	37	39
-Reduction in Damage to Shorefront Structures			
-Emergency Costs			
-Future Costs			
-Future Development			
-Affluence	1	1	1
-Reduced F.I. Overhead	2	2	2
-Sea Level Rise	4	5	5
Total Annual Benefits	38	45	47
Total Annual Costs	214	237	256
Benefit/Cost Ratio	0.1	0.1	0.1
Net Benefits	-176	-192	-209

TABLE 81  
OPTIMIZATION OF PLAN 1  
REVERE (BACKSHORE AND POINT OF PINES)  
(\$1000 FEB. 1988)

Benefits and Costs	<u>Level of Protection</u>		
	<u>100 Year</u>	<u>500 Year</u>	<u>SPN</u>
Benefits:			
-Inundation Reduction	2,831	2976	3013
-Reduction in Damage to Shorefront Structures	157	157	157
-Emergency Costs	160	163	163
-Future Costs			
-Future Development	9	18	26
-Affluence	169	172	173
-Reduced F.I. Overhead	43	43	43
-Sea Level Rise	550	606	616
-Recreation	415	415	415
Total Annual Benefits	4,334	4,550	4,606
Total Annual Costs	3,273	3,619	3,925
Benefit/Cost Ratio	1.3	1.3	1.2
Net Benefits	1,065	931	681

TABLE 82  
OPTIMIZATION OF PLANS

	PLAN 1 (without Point of Pines)	PLAN 1 (with Point of Pines)	PLAN 3
Total Annual Benefit	6,922	8,825	10,860
Total Annual Cost	6,554	7,471	8,942
Net Benefit	368	1,354	1,918
BCR	1.1	1.2	1.2

In Table 82, Plan 1, without Point of Pines, includes the 500 year level of protection in Lynn and Saugus and 100 year level of protection in Revere Backshore (Town Line Brook LPP is not included). Plan 1, with Point of Pines adds 100-year level of protection in Point of Pines to the LPP Plan. Plan 3 is the SPN level of protection for alignment 2.

Based on benefit and cost estimates presented above, the plan that maximizes NED benefits is Plan 3 with the floodgate at alignment \_\_\_\_\_. The composite Plan 1 does not include the Northgate LPP and the Point of Pines LPP. Northgate is not economically feasible with a BCR less than one and

although Point of Pines is economically feasible, the plan cannot be implemented for financial reasons. The Point of Pines LPP is essentially the result of a Section 205 investigation that received approval from OCE but was not implemented as the locals indicated that they did not have the financial resources to fund their share of the project.

### Sensitivity Analysis

Sensitivity analyses are presented discussing accelerated sea level rise and project payback period.

### Accelerated Sea Level Rise

Historical sea level rise of one foot is assumed in the analysis. It is possible that sea level rise would range from two to four feet over the one hundred year life of the project. This section considers the effects of a sea level rise of 4.2 feet. Due to the flatness of the stage frequency function, an increase in stillwater levels of 4.2 feet would shift this function to the extent that SPN storm tide levels would have a frequency of exceedence about each year. Thus in the without project condition the study area which is already suffering approximately eight million annually in primary flood damages would be subjected to much greater damages. To prevent flooding from being so frequent and damages so high that as sea level gradually rises communities and property owners would gradually raise their shorefronts to keep pace with sea level rise, although likely to remain prone to severe flooding from infrequent coastal storms. For example, in the Pines River-Riverside damage zone in Revere expected annual damages per residential structure is approximately \$2,600. With a sea level rise of 4.2 feet, damage per structure would increase to \$24,000.

If the decision has been made to build the project and the project is put in place, modifications to the size of project may be made if flooding conditions warrant such action. Residual (with project) damages can be reduced by increasing the height of the Regional Plan features. If the reduction in residuals is greater than the cost of increasing the shorefront features' height, then the addition would be economically justified.

### Payback Period

The payback period is the length of time required to recover the first cost of the investment from the net cash flow produced by that investment for an interest rate equal to zero. The first cost of the Saugus River and Tributaries Flood Damage Reduction - Project is estimated to be \$79,000,000, including non-Federal costs such as maintenance. The net cash flow can be defined as the difference between annual benefit and annual O&M cost. Annual benefit is estimated to be \$10,860,000 and annual O&M is estimated to be \$325,000. Thus net cash flow is \$10,535,000 annually. The initial investment will be recouped in eight years, or the payback period is eight years.

**SAUGUS RIVER AND TRIBUTARIES  
FLOOD DAMAGE REDUCTION STUDY**

**LYNN, MALDEN, REVERE  
AND SAUGUS, MASSACHUSETTS**

**SOCIOECONOMIC**

**APPENDIX H**

Department of the Army  
New England Division, Corps of Engineers  
424 Trapelo Road  
Waltham, Massachusetts 02254-9149

June 1989

## INTRODUCTION

This appendix was prepared for NED by IEP, Inc. It is a description of the affected environment and project impacts. It should be noted, the IEP preliminary assessment of wetland losses cited in the report has undergone extensive investigation by the NED's Regulatory Enforcement Unit. IEP estimated 60 acres of wetland filled from 1978 to 1988, while the detailed investigation by NED found 4.7 acres filled. A summary of the Enforcement Unit's findings are included in the Plan Formulation Appendix.

#### ADDENDUM

Since completion of this report by IEP, the following changes should be noted:

(1) In the first paragraph of page ii, the reference to "I-93" should read "I-95".

(2) On page 42, the modified 100-year flood elevation for Flood Zone 3AC in Revere should read "6.1" instead of "6.2".

(3) On page 87 in the last paragraph the phrase in parentheses should read "conditions for a 100-year storm event were experienced in 1978".

(4) On page 91, with the exception of zone 5B in Revere, all 100 year flood elevations that currently are at 7.3 should be changed to 8.0 as the floodgates will generally not be operated below this elevation. In Revere zone 5B, 7.3 should be changed to 9.4. Also zone 4B in Revere the 100 year modified elevation should be 3.5.

(5) On page 113, the last sentence in the first paragraph on "Minimum Sea Level Rise Effects" should read "The factor of safety of 2 and 3 feet also allows for the historic sea level rise of about one foot per century.

(6) On page 114, the second line from the bottom of the page should read "exceeds two feet or the factor of safety...."

(7) In addition to the changes referenced above, in some instances data referenced in the supporting narrative is not consistent with data presented in the tables. The data as presented in tables were used in the subsequent analysis.

(8) On page 108, in paragraph "c) Post Construction", the first line should read: "The operation of the floodgates will be electrically powered and have a backup generator."



NECIV-6

**SOCIOECONOMIC ASSESSMENT FOR  
THE SAUGUS RIVER AND TRIBUTARIES**

**FLOOD DAMAGE REDUCTION STUDY  
LYNN, MALDEN, REVERE, AND SAUGUS  
MASSACHUSETTS**

**July, 1988**

**Prepared For:**

**New England Division  
Corps of Engineers  
424 Trapelo Road  
Waltham, Massachusetts**

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**Table of Contents**

	<u>Page</u>
<b>Executive Summary</b>	
<b>VI. Affected Environment, Discussion of Historical Conditions, Existing Conditions and Future Conditions Without a Federal Project, Future Conditions Assumptions .....</b>	<b>i</b>
<b>B. Significant Resources .....</b>	<b>1</b>
<b>11. Social and Economic Factors-Communities and Study Area .....</b>	<b>1</b>
a) Land Use .....	1
(1) Communities .....	4
(2) Study Area .....	16
(a) Historical and Existing .....	20
(b) Plans for Development .....	26
(c) Pressures for Development .....	28
(d) Barriers to Development .....	29
i) Regulatory .....	29
ii) Topographic Constraints .....	39
iii) Flood Plain Construction Costs .....	43
iv) Other Factors Restricting Development .....	45
(e) Future Development Without a Federal Project.....	46
b) Property Values and Housing .....	53
c) Business and Industrial Activity and Regional Growth .....	57
(1) Commercial Fishing and Commercial Fishing Fleet .....	61
d) Employment .....	63
e) Population & Community Growth, Including Displacement .....	66
f) Public Facilities and Services and Tax Revenues .....	68
g) Transportation .....	69
(1) Streets and Highways .....	69
(2) Rail Systems .....	70
h) Summary of Social and Economic Factors .....	71
<b>12. Navigation (Not Contracted With IEP) .....</b>	
<b>13. Recreation and Open Space - Study Area .....</b>	<b>73</b>
<b>14. Noise .....</b>	<b>77</b>
<b>15. Air Quality .....</b>	<b>78</b>

**VII. Environmental Effects of Detailed Plans Including Construction,  
Operational and Maintenance Phase Effects**

<b>A. Plan Impacts .....</b>	<b>81</b>
11. Social and Economic Factors - Communities and Study Area.....	81
a) Land Use - Direct and Induced Effects .....	85
b) Property Values and Housing .....	92
c) Business, Industrial, and Fishing Activity .....	93
d) Employment .....	94
e) Population & Community Growth, Incl. Displacement .....	95
f) Public Facilities and Services and Tax Revenues .....	96
g) Transportation .....	96
h) Summary of Social and Economic Factors .....	99
12. Navigation (Not Contracted With IEP) .....	
13. Recreation and Open Space .....	101
14. Noise .....	103
a) Construction .....	103
b) Floodgate.....	103
c) Lynn Harbor, Revere Beach and Point of Pines .....	104
d) Post Construction Impacts .....	104
15. Air Quality .....	106
a) Dust .....	106
b) Emissions .....	106
(1) Carbon Monoxide .....	107
(2) Oxides of Nitrogen .....	107
(3) Sulfur Dioxide .....	107
(4) Particulates .....	107
(5) Hydrocarbons .....	107
(6) Photochemical Oxidants .....	108
c) Post Construction .....	108

	<u>Page</u>
IX. Sea Level Rise - A Sensitivity Analysis .....	109
A. Affected Environment .....	109
1. Minimum Sea Level Rise Effects .....	109
2. Accelerated Sea Level Rise Effect .....	111
B. Environmental Effects of Detailed Plans .....	113
1. Minimum Sea Level Rise Effects .....	113
2. Accelerated Sea Level Rise Effects .....	114
Bibliography and References .....	117

**List of Tables**

	<b><u>Page</u></b>
Table 1. Land Use Change: 1951-1980; Lynn .....	5
Table 2. Land Use Change: 1951-1980; Saugus .....	8
Table 3. Land Use Change: 1951-1980; Revere .....	11
Table 4. Land Use Change: 1951-1980; Malden .....	15
Table 5. Actual Land Use: Lynn .....	22
Table 6. Actual Land Use: Saugus .....	24
Table 7. Actual Land Use Revere .....	25
Table 8. 100-Year Flood Elevations Adjacent to Tidal Marsh Areas .....	42
Table 9. Vacant Land: Lynn .....	47
Table 10. Vacant Land: Saugus .....	48
Table 11. Vacant Land: Revere .....	50
Table 12. Building Permits For New Housing Units .....	51
Table 13. Housing Characteristics and Property Values, 1980.....	54
Table 14. Median House and Condominium Prices .....	55
Table 15. Annual Payroll and Wages, 1986 .....	58
Table 16. Personal Income and Earnings, 1983-2035 .....	60
Table 17. Annual Average Employment, 1987 .....	64
Table 18. Boston NECMA, Employment by Place of Work and by Industry 1983 and Projected 1990 to 2015 .....	65
Table 19. Population .....	67
Table 20. FEMA Funding to Municipalities After the Blizzard of 1978 ...	68
Table 21. 1986 Air Quality .....	79
Table 22. Option 1: Construction and Features, Duration, Trucking, Labor. Local Protection Plans: 500-Year Level of Protection.	84
Table 23. Option 3: Regional Floodgate Plan - Constuction: Duration Trucking, Labor .....	86
Table 24. Modification of 100-Year Flood Elevations Adjacent to Tidal Marsh Areas with the Flood Reduction Project .....	91
Table 25. Categories of Decisions Sea Level Rise Will Influence (Hoffman, et al., 1983) .....	110

### List of Figures

	<u>Page</u>
Figure 1. Locus Map .....	2
Figure 2. General Location of Wetland Filling in Lynn (1978-1987) ....	7
Figure 3. General Location of Wetland Filling in Saugus (1978-1987) ..	9
Figure 4. General Location of Wetland Filling in Revere (1978-1987)...	13
Figure 5. City of Lynn Flood Zones .....	17
Figure 6. Town of Saugus Flood Zones .....	18
Figure 7. City of Revere Flood Zones .....	19

APPENDIX A	Preliminary Assessment of Wetland Filling (1978-1987)
APPENDIX A-1	Wetland Community Types
APPENDIX A-2	Specific Locations of Wetland Filling in Lynn (1978-1987) Areas 1, 2, and 3
APPENDIX A-3	Specific Locations of Wetland Filling in Lynn (1978-1987) Areas 4 and 5
APPENDIX A-4	Specific Locations of Wetland Filling in Saugus (1978-1987) Areas 1 and 2
APPENDIX A-5	Specific Locations of Wetland Filling in Saugus (1978-1987) Areas 3 and 4
APPENDIX A-6	Specific Locations of Wetland Filling in Saugus (1978-1987) Areas 5, 6, 7, and 8
APPENDIX A-7	Specific Locations of Wetland Filling in Saugus (1978-1987) Areas 9 and 10
APPENDIX A-8	Specific Locations of Wetland Filling in Revere (1978-1987) Areas 1 and 2
APPENDIX A-9	Specific Locations of Wetland Filling in Revere (1978-1987) Areas 3, 4, 5, and 6
APPENDIX A-10	Specific Locations of Wetland Filling in Revere (1978-1987) Areas 7 and 8
APPENDIX A-11	Specific Locations of Wetland Filling in Revere (1978-1987) Areas 9

## **Executive Summary**

## EXECUTIVE SUMMARY

The purpose of this study is to document the potential socioeconomic effects of the proposed Corps of Engineers flood reduction plans for the Saugus/Pines River estuary. A primary goal of this study was to determine whether the flood reduction projects would encourage growth and development in the Saugus estuary and in the associated flood plains. Future development trends were studied without any project and then considered with the Options 1, 2 and 3.

Future development in the study area will most likely not be affected by construction of any federal flood reduction project options. Inducement to construction in the marsh will be negligible due to the strict regulations under the Wetland Protection Act. This assumes improved implementation and enforcement.

### OPTIONS 1 and 3

Construction in the flood plain is presently not prohibited, only more costly due to building code requirements. If the flood plain were eliminated from the upland areas, there would be a minor economic incentive (lower construction cost) for development. Two factors make this incentive relatively insignificant. First, other economic factors (interest rates, demand, etc.) outweigh reduced construction costs for deciding whether to build. Second, the scarcity of building sites shown by the developable lot study (360 residential, 163 zoned industrial, and 57 commercial) means there would be relatively little change. Most significantly, all of these sites are developable now.

Historically, the Saugus River estuary was much larger than its present dimension of 1,700 acres. Growth and development in the communities of Lynn, Malden, Saugus, and Revere have had a profound effect on the loss of salt marsh. From 1951 to 1980 a total of 623 acres of salt marsh was lost in Lynn, Revere, and Saugus (MAPC, 1986). Large projects such as the I-93 embankment, the RESCO plant and the Dematteo landfill contributed to this loss. Together the landfill and RESCO amounted to approximately 300 acres of filled salt marsh.

Filling of the estuary has slowed significantly since enactment of the Wetlands Protection Act but still continues. Studies of the aerial photography taken in 1978 and 1987 showed that an additional 60 acres had been filled. This filling had occurred along the edges of the marsh. It is presumed that any future filling of the marsh will occur along the perimeter at the edge of the upland, rather than additional centrally located large scale project. Another finding from the aerial photography is the increased occurrence of Phragmites australis, an "invader" species. Phragmites is regulated under state law as an inland wetland species rather than coastal, making it more susceptible to permitted filling. Strong environmental laws and regulations at the federal, state, and local levels have been in effect since the latter 1970's, essentially prohibit development within salt marsh environments.

Future growth and development of the flood plain without the project within Lynn, Saugus, and Revere will depend on many factors. The primary factor will be whether developers and investors find it economical. Additional factors are the amount of vacant land, development trends, population growth, local economic growth, and future demand.

A Developable Lot Study determined that there are 237 acres of developable land in the Corps' Standard Project Northeaster (SPN). Of these, 160 acres are in the Corps' 100-year flood zone. Development of this land would, at

the minimum, add an additional 588 buildings. The rate at which these buildings will be built depends on many factors. Since 1982, building permits for new residential construction has increased in Lynn, Revere, and Saugus. Revere has experienced the most dramatic increase, increasing by 1,005 percent. Lynn increased 110 percent, and Saugus 66 percent.

Recently, however, the housing market has dropped. Median housing prices have dropped in the Boston area for the second quarter in a row (Boston Globe, 1988). Realtors say that Revere's condominium market is weakening due to overbuilding.

Other types of economic growth have been slow to come to the study area. Though the area is within commuting distance of Boston, it has not been booming like other areas in Massachusetts. Total employment in Lynn and Revere has decreased by 12.8 percent while across the state it increased 8.6 percent. Only Saugus has continued to grow. The unemployment rate was also higher in 1987 in Lynn (3.6 percent) and Revere (3.7 percent) than across the state (3.2 percent) (Massachusetts Division of Employment Security, 1987).

The local economics are heavily dependent on service and wholesale and retail trade sectors. These sectors of the economy have the lowest paying jobs. Only Lynn's economy is more diversified with more people in manufacturing.

Although the population has decreased in all the communities, population within the study area has grown. Also, the number of households is increasing, creating new demand for housing. Housing prices have risen in all the communities, just as they have across the state. Some buyers have been attracted to houses in the area because of the lower prices in comparison to other Boston communities. Although housing values have risen in water-front areas, the desirability of building and living in the flood plain remains an issue, primarily in East Saugus and Revere.

After the project (either Option 1 or 3) is completed, property values would tend to rise due to reduction in insurance rates and the ability to rehabilitate existing structures without having to raise them to current 100-year flood levels.

After the completion of the project, there will be little or no impact to population growth, employment or industrial activity. Transportation in general would not be affected, except that safe access would be available over low-lying local roads (and Route 107 under Option 3) during major storm events.

The construction activity will have a localized negative impact with regard to traffic and noise. These will last the duration of the project.

## **OPTION 2**

Floodproofing of less the 5 percent of the existing structures in the study area would create no significant social or economic impacts. The impacts would be highly site-specific.

## **VI. B. Significant Resources**

**VI. B. 11. Social & Economic Factors**

## **B. Significant Resources**

### **11. Social and Economic Factors - Communities and Study Area**

The following is a detailed analysis of socioeconomic factors affected by flooding in the four communities surrounding the Saugus River Marsh (Figure 1). Lynn, Saugus, Revere, and Malden were all heavily impacted by the 1978 Blizzard. This examination of their land use patterns and infrastructure will help in understanding what the social and economic impacts would be if a major flood reduction effort were not undertaken.

#### **a) Land Use**

Land use in a community is determined by a number of factors; its zoning and subdivision regulations, topography, economy, history, population and regional location. One of the primary influences on the communities in the communities of Lynn, Saugus, Revere, and Malden is their proximity to Boston. Being located approximately ten miles from downtown Boston (about 20 minutes commuting time), has had a major influence on their economic growth and land use patterns. After World War II, the sites became densely populated bedroom communities of Boston. In the 1970's, with the downturn in the state's economy, the communities in the study area suffered from slow economic growth, and population decline (from 1970 to 1980 population declined by approximately 8 percent). With a stronger economy in Boston in the 1980's, the effects have rippled outward to surrounding areas.

The recent strong economy has increased economic growth and demand for housing in the study area. Businesses are locating outside Boston, seeking lower land prices. The proximity to Logan Airport, location on the transportation corridor north on I-95, and ocean access are additional benefits that are beginning to attract business to the area.

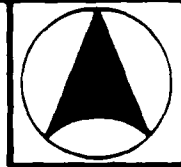


**FIGURE 1: LOCUS MAP**

**LEGEND**

- TOWN BOUNDARIES
- SITE LOCUS

SCALE IN MILES



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Though population has continued to decline in the communities since 1980, housing demand is rising due to the increased number of households. Households are increasing due to the higher incidence of diverse, young adults staying single longer, and the increased longevity and independence of the elderly.

Low property prices in comparison to surrounding communities have also increased the demand for housing. Building permits for new housing construction have been increasing since 1982 in all of the communities. The area's proximity to the ocean has led to a great increase in the building of condominiums along Revere Beach with prices ranging from \$120,000 to \$200,000. Condominiums with high prices have also been successful in Lynn Harbor given the amenities of Lynn Harbor, Heritage Park, and the Lynn Waterfront.

Officials in the communities are attempting to spur economic growth through aggressive redevelopment plans. They have tried to attack their poor image problems through zoning changes and promotional campaigns such as the "Step Up With Lynn" program. Revere replaced the old, unattractive amusement zoning district with high-rise residential districts. Saugus has hired consultants to rewrite their Master Plan and recommend redevelopment actions.

The loss of tidal wetlands in these communities has been high, historically, as it has been throughout the Boston metropolitan area. Prior to the mid to late 1960's, there was no wetland legislation to protect wetlands. Currently, however, federal and state laws and regulations, as well as local bylaws, place stringent control on the loss of wetlands. One would expect the losses to stop with such protection, but a preliminary assessment indicates this may not be true.

Land use data showing wetland losses is tabulated for each community for the years 1951, 1970, and 1980. To acknowledge more recent tidal wetland losses, a preliminary assessment was conducted by comparing 1" = 400' scale aerial photography dated in 1978 and 1987. This comparative method is different than that utilized to tabulate the historic losses, therefore, the two cannot be correlated. It is this continued loss of wetlands that deserves attention.

### **(1) Communities**

#### **Lynn**

Lynn was first established in 1637 and was incorporated as a city in 1850. Lynn is approximately 11 square miles and has a density of 7,545 persons per square mile.

Lynn has a greater industrial base than either Saugus or Revere. The largest industry is the General Electric Plant which was founded in 1892, employs 8,000 people, and occupies nearly 130 acres. At one time, Lynn was the leading shoe manufacturer in the world. As the world market shifted and cheaper labor was found overseas, the shoe industry declined. In 1981, much of the old shoe manufacturing district was destroyed in a fire. In its place, the Lynn Community College has been built and a new office development constructed.

Table 1 presents land use patterns in Lynn from 1951 to 1980. The amount of urban land uses has changed slightly while agriculture, open land, and forest have decreased.

**Table 1**  
**LYNN**  
**LAND USE CHANGE: 1951 - 1980**

LAND USE CATEGORY	1951	1971	1980	PERCENT OF 1980 TOTAL	ACREAGE CHANGE (%) 1971-1980
<b>URBAN</b>					
Industrial (UI)	351	433	433	6	0
Commercial (C)	217	314	340	5	8
Dense Residential (R1)	2868	2741	2751	37	0
Medium Residential (R2)	279	267	267	4	0
Sparse Residential (R3)	53	50	50	1	0
Transportation (UT)	123	156	131	2	-19
Open and Public (UO)	479	392	391	5	0
URBAN TOTAL	4370	4353	4363	59	0
<b>AGRICULTURE</b>					
Cropland (AC)	30	0	0	0	0
Pasture (AP)	84	0	0	0	0
Woody Perennials (WP)	5	5	5	0	0
AGRICULTURE TOTAL	119	5	5	0	0
<b>OPEN (O) TOTAL</b>	312	163	146	2	-10
<b>FOREST (F) TOTAL</b>	2046	1953	1950	26	0
<b>WETLANDS</b>					
Water (W)	398	457	457	6	0
Salt Wetlands (SW)	79	65	65	1	0
Fresh Wetlands (FW)	60	94	91	1	-3
WETLANDS TOTAL	537	616	613	8	0
<b>OUTDOOR RECREATION</b>					
Land Based (RS & RP)	+	183	196	3	7
Water Based (RW)	+	35	35	0	0
RECREATIONAL TOTAL	+	218	231	3	6
<b>MINING (M) TOTAL</b>	+	71	71	1	0
<b>WASTE DISPOSAL (UW) TOTAL</b>	+	5	5	0	0
<b>ACREAGE TOTAL</b>			7384		

+ These categories were not measured in 1951.

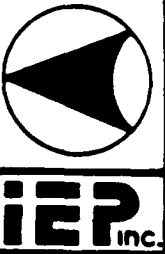
Source: Metropolitan Area Planning Council, 1986.

The wetlands environment, defined as open water and fresh and salt marshes, had a total of 537 acres in 1951. Only 79 acres, or 15 percent of the total, was salt marsh. A loss of 14 acres of salt marsh occurred in a 20-year period between 1951 and 1971 and none were lost between 1971 and 1981. However, the filling of wetlands continues to occur (Figure 2). Approximately 12 acres have been filled near mudflats (Appendix A-2) and an old railroad bed (Appendix A-3) since 1978.

### **Saugus**

Saugus was first settled in 1629, and as in Revere, farming was the principal industry. The town was incorporated in 1815. Shoe manufacturing became a significant industry which was initially carried on in people's homes. As the industry grew, it relocated to factories in Lynn. Land use in Saugus is primarily residential and open/undeveloped. Saugus is 11.5 square miles with a population density of 2,357 persons per square mile.

Table 2 presents land use changes in Saugus from 1951 to 1980. Note that urban land uses, open land, and waste disposal have increased while agriculture, forests, and wetlands have decreased. Again, since 1971, the decrease in salt water wetlands has been significantly less than the prior 20-year period. Between 1951 and 1971, some 325 acres were lost to filling. This represented more than one-third of the total salt water wetlands in the Town. Most of this filling can be attributed to the I-95 embankment, the RESCO plant, and associated landfill. According to the table, between 1971 and 1980, only ten additional acres of marsh were lost, about one percent of the total. However, wetland filling continues to occur (Figure 3). Approximately 26 acres have been filled near high marsh and tidal creeks (Appendix A-4), phragmites (Appendix A-5, A-6), and high marsh (Appendix A-7) since 1978.



**FIGURE 2: GENERAL LOCATION OF WETLAND FILLING IN LYNN (1978-1987)**

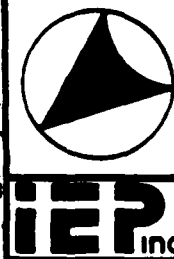
SOURCE: U.S.G.S. QUADRANGLE, LYNN

**Table 2**  
**SAUGUS**  
**LAND USE CHANGE: 1951 - 1980**

LAND USE CATEGORY	1951	1971	1980	PERCENT OF 1980 TOTAL	ACREAGE CHANGE (%) 1971-1980
<b>URBAN</b>					
Industrial (UI)	28	50	67	1	34
Commercial (C)	114	306	331	5	6
Dense Residential (R1)	1369	1399	1423	19	2
Medium Residential (R2)	607	620	710	10	13
Sparse Residential (R3)	102	105	105	1	0
Transportation (UT)	68	172	172	2	0
Open and Public (UO)	128	122	122	2	0
URBAN TOTAL	2416	2774	2930	40	5
<b>AGRICULTURE</b>					
Cropland (AC)	227	47	24	0	-49
Pasture (AP)	338	14	14	0	0
Woody Perennials (WP)	7	35	10	0	-250
AGRICULTURE TOTAL	572	96	48	1	-100
<b>OPEN (O) TOTAL</b>	157	243	216	3	-11
<b>FOREST (F) TOTAL</b>	2629	2505	2437	33	-3
<b>WETLANDS</b>					
Water (W)	165	528	528	7	0
Salt Wetlands (SW)	949	624	614	8	-2
Fresh Wetlands (FW)	432	190	186	3	-2
WETLANDS TOTAL	1546	1342	1328	18	-1
<b>OUTDOOR RECREATION</b>					
Land Based (RS & RP)	+	145	150	2	3
Water Based (RW)	+	0	0	0	0
RECREATIONAL TOTAL	+	145	150	2	3
<b>MINING (M) TOTAL</b>	+	67	53	1	-26
<b>WASTE DISPOSAL (UW) TOTAL</b>	+	148	158	2	6
<b>ACREAGE TOTAL</b>			7320		

+ These categories were not measured in 1951.

Source: Metropolitan Area Planning Council, 1986.



**FIGURE 3: GENERAL LOCATION OF WETLAND FILLING IN SAUGUS (1978-1987)**



SOURCE: U.S.G.S. QUADRANGLE, BOSTON NORTH AND LYNN

## **Revere**

Originally settled in 1621, Revere was first named Rumney Marsh due to its extensive wetlands systems. At first annexed as a part of Boston in 1634, Revere became a part of Chelsea in 1739. It was incorporated as a town in 1871 and as a city in 1915. Revere is approximately seven square miles, or approximately 4,000 acres, with a population density of 7,443 persons per square mile. Approximately 1,000 acres are wetlands. Fifty-five percent of the remaining acreage has been developed primarily for residential use.

Since its founding, farming was the principal livelihood in Revere. This began to change when Revere Beach became a popular summer resort for Boston residents. With the building of the Boston Revere Beach and Lynn Railroad in 1875, the population rapidly increased from 1,197 in 1870 to 3,637 in 1885, to 5,668 by 1890.

The greatest population growth occurred after World War II. Rapid residential development replaced the farmlands so that today, Revere is principally a densely populated residential area. There is little industry and employment is principally with small businesses in the service sector. The Wonderland Race Track and Revere Beach attract visitors from throughout the region. Transportation systems such as the Massachusetts Bay Transportation Authority (MBTA) and major highway systems funnel commuter traffic through Revere.

Land use has changed in Revere since 1951 as shown in Table 3. Total urban land and wetlands have decreased while open land and forest acreage has increased. Current land use within the study is primarily residential with some commercial and industrial uses.

**Table 3**  
**REVERE**  
**LAND USE CHANGE: 1951 - 1980**

LAND USE CATEGORY	1951	1971	1980	PERCENT OF 1980 TOTAL	ACREAGE CHANGE (%) 1971-1980
<b>URBAN</b>					
Industrial (UI)	160	191	199	5	4
Commercial (C)	98	198	270	7	27
Dense Residential (R1)	1110	1629	1637	40	0
Medium Residential (R2)	253	70	70	2	0
Sparse Residential (R3)	152	10	10	0	0
Transportation (UT)	287	295	295	7	0
Open and Public (UO)	569	118	65	2	-82
URBAN TOTAL	2629	2511	2546	63	1
<b>AGRICULTURE</b>					
Cropland (AC)	190	0	0	0	0
Pasture (AP)	3	3	0	0	0
Woody Perennials (WP)	0	10	10	0	0
AGRICULTURE TOTAL	193	13	10	0	-30
<b>OPEN (O) TOTAL</b>	<b>95</b>	<b>142</b>	<b>110</b>	<b>3</b>	<b>-23</b>
<b>FOREST (F) TOTAL</b>	<b>26</b>	<b>130</b>	<b>130</b>	<b>3</b>	<b>0</b>
<b>WETLANDS</b>					
Water (W)	138	295	295	7	0
Salt Wetlands (SW)	837	563	563	14	0
Fresh Wetlands (FW)	134	65	65	2	0
WETLANDS TOTAL	1109	923	923	23	0
<b>OUTDOOR RECREATION</b>					
Land Based (RS & RP)	+	180	180	4	0
Water Based (RW)	+	115	115	3	0
RECREATIONAL TOTAL	+	295	295	7	0
<b>MINING (M) TOTAL</b>	<b>+</b>	<b>25</b>	<b>25</b>	<b>1</b>	<b>0</b>
<b>WASTE DISPOSAL (UW) TOTAL</b>	<b>+</b>	<b>15</b>	<b>15</b>	<b>0</b>	<b>0</b>
<b>ACREAGE TOTAL</b>			<b>4054</b>		

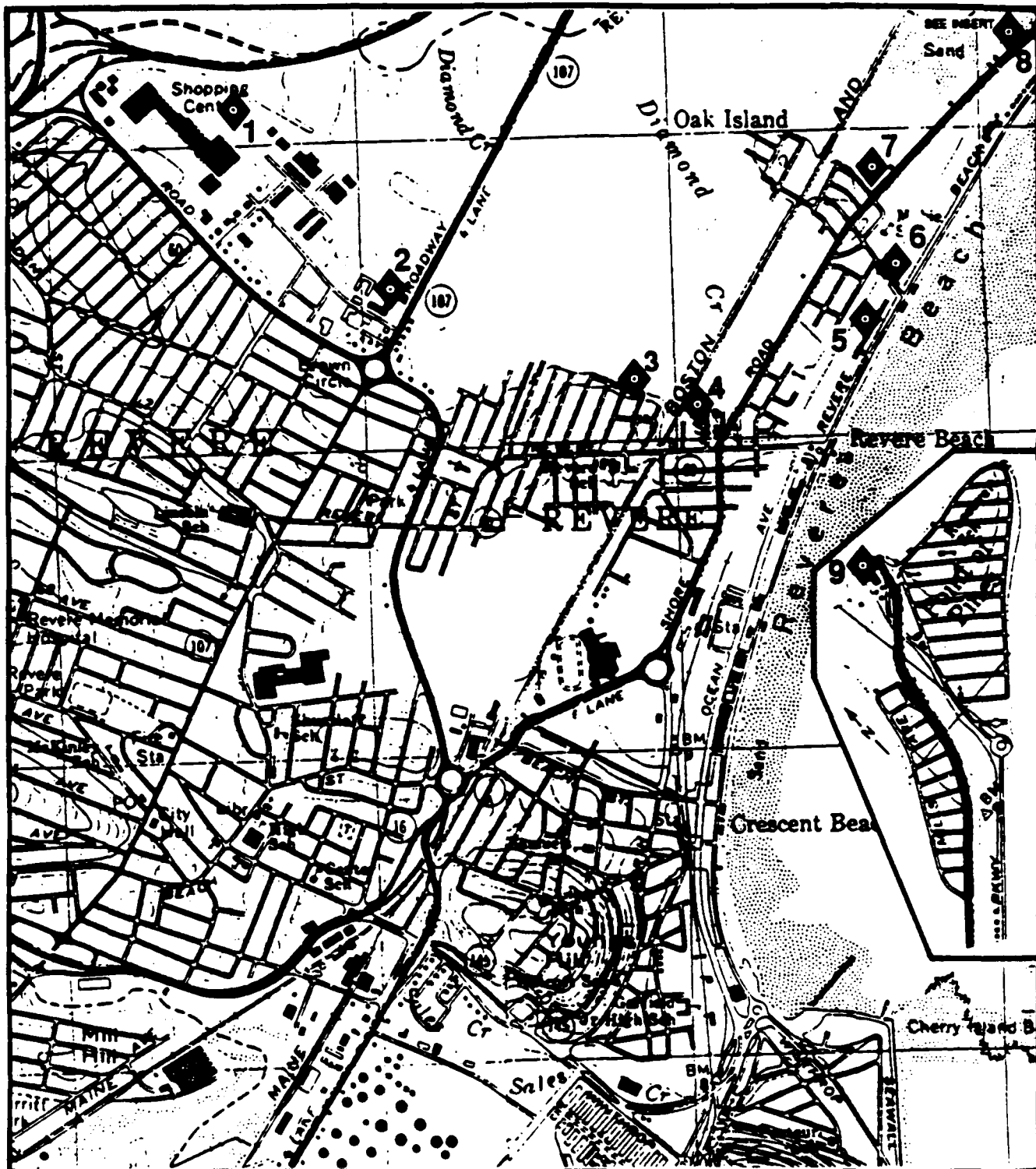
+ These categories were not measured in 1951.

Source: Metropolitan Area Planning Council, 1986.

The three large wetland systems in Revere had a major impact on the shape of development patterns. To the east of the city, the Belle Isle Marshes form a boundary between Revere and East Boston and Chelsea. The second major wetlands system has mostly been filled in since the early 1900's and is now the site of the Revere High School, Towle Industries, and Wonderland Dog Track and are also in the study area. Only part of the wetland system remains due to a tide gate preventing salt water exchange. Residential development has grown away from the marsh. The third major wetlands system is the Pines River tidal marsh which is included in the study area of the Saugus River Floodgate. While the total wetlands system acreage is not subdivided into the three major areas in Table 3, it can be noted that 75 percent of the 1,109 total acres was salt marsh in 1975. Of the 837 acres of salt marsh, 33 percent, or 274 acres, was lost in a 20-year period between 1951 and 1971 with no loss measured between 1971 and 1980.

Wetland filling continues to occur in the Pine River tidal marsh (Figure 4). Approximately 21 acres have been filled between existing upland and high marsh (Appendix A-8, near phragmites (Appendix A-9), near low marsh (Appendix A-10), and near mud flats (Appendix A-11) since 1978.

The other major factor to impact the physical layout of Revere has been the zoning and subdivision regulations. Since the 1920's, zoning in Revere has remained relatively unchanged and has allowed dense residential development. One of the first changes in the zoning regulations was to replace the amusement park zone along Revere Beach with a high-rise residential district in an effort to get rid of the park which, according to the Master Plan, was responsible for a "seedy" atmosphere in this part of the town. Allowing high-rise residential districts ushered in a substantial increase in development in this area. Since this change in 1983, 1,850 new units have been built.



**FIGURE 4: GENERAL LOCATION OF WETLAND FILLING IN REVERE (1978-1987)**



SOURCE:  
U.S.G.S. QUADRANGLE, BOSTON NORTH AND LYNN

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## **Malden**

As with the other communities, Malden principally had an agricultural and fishing based economy when it was incorporated as a town in 1649. At the beginning of the 18th century, factories began to be built in the town. Early industries were connected to the maritime trade, such as the silk-dyeing business established in conjunction with the China trade. Eventually, tanning and shoe manufacturing became the principal industries in Malden.

Many immigrants settled into the town to work in the factories. In 1881, Malden was officially incorporated as a city. In 1980, Malden's population reached 53,386 - a drop from previous years. Malden's peak population was 60,000 in 1950, the most densely populated community with 11,122 people per square mile. Covering 5.13 square miles, Malden's primary land use is residential. Residential land uses comprise 59 percent of the total. From 1951 to 1980, nearly all urban land uses declined except for increases in commercial and transportation uses (Table 4).

## **Summary of Wetland Losses**

Growth and development of Lynn, Saugus, and Revere has had a profound effect on the loss of salt marsh, particularly within the Saugus and Pines River estuary. While it cannot be determined how much tidal wetland was lost prior to 1951, it is assumed that the loss was significant. Since 1951, a 37 percent loss of salt marsh has occurred within the three communities.

Two projects located in the central portion of the estuary consumed 300 acres of salt marsh and a similar amount has been lost around the perimeter of Saugus and Lynn. It is the edge of the upland/salt marsh area that would be potentially lost to any future incremental growth and development rather than any additional, centrally located, large-scale projects.

Table 4.  
MALDEN  
LAND USE CHANGE: 1951 - 1980

LAND USE CATEGORY	1951	1971	1980	PERCENT OF 1980 TOTAL	PERCENT CHANGE 1971-1980
URBAN					
Industrial (UI)	243	208	216	7	4
Commercial (C)	118	215	221	7	3
Dense Residential (R1)	1707	1620	1669	51	3
Medium Residential (R2)	283	252	252	8	0
Sparse Residential (R3)	15	15	15	0	0
Transportation (UT)	17	34	45	1	24
Open and Public (UO)	445	318	322	10	1
URBAN TOTAL	2828	2662	2740	84	3
AGRICULTURE					
Cropland (AC)	8	0	0	0	0
Pasture (AP)	0	0	0	0	0
Woody Perennials (WP)	0	0	0	0	0
AGRICULTURE TOTAL	8	0	0	0	0
OPEN (O) TOTAL	89	51	50	2	-2
FOREST (F) TOTAL	278	374	307	9	-22
WETLANDS					
Water (W)	14	20	20	1	0
Salt Wetlands (SW)	0	0	0	0	0
Fresh Wetlands (FW)	43	5	5	0	0
WETLANDS TOTAL	57	25	25	1	0
OUTDOOR RECREATION					
Land Based (RS & RP)	+	102	95	3	-7
Water Based (RW)	+	0	0	0	0
RECREATIONAL TOTAL	+	102	95	3	-7
MINING (M) TOTAL	+	30	30	1	0
WASTE DISPOSAL (UW) TOTAL	+	8	5	0	-60
ACREAGE TOTAL			3252		

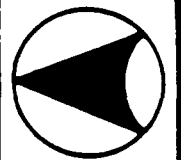
+ These categories were not measured in 1951.

Source: Metropolitan Area Planning Council, 1986.

## **(2) Study Area**

The study area for the socioeconomic assessment is contained below the Standard Project Northeaster (SPN) elevation in Lynn, East Saugus, and Revere (Malden is not included). It encompasses approximately 3,270 acres in sections of the three communities (Figures 5, 6, and 7). In Lynn, the study area includes the FEMA flood plain which extends into the southern section of the city and includes the General Electric Plant, South Harbor area, and a mix of development along the Saugus River. The study area in Saugus includes the community of East Saugus, areas along the upper Saugus River and Shute Brook and a large portion of the marsh. Approximately one third of Revere is included in the study area. The areas of Revere Beach, Point of Pines, Northgate Shopping Center, the Garfield School behind Crescent Beach, the Wonderland Park and Towle Industry areas, Oak Island, Riverside and sections of the Pines and Saugus River one quarter of the study area is tax exempt (state owned).

In each of these areas, the Army Corps has identified an approximate Standard Project Northeaster (SPN), the 500-year, the 100-year, the 10-year, and the 2-year flood levels. These boundaries are used for assessing land use which may be affected by any flood control project. Current land-use information was determined by identifying each parcel within the SPN with a state "Property According to Use Code." Residential, commercial, industrial, mixed uses, tax exempt, and vacant property were identified on assessor's maps by color codes. Acreage and the number of parcels were tallied by land use for two zones in the study area: between the SPN and the Corps 100-year flood plain boundary, and; below the 100 year flood boundary.

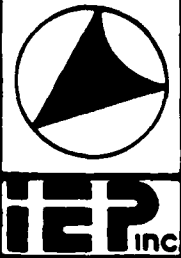


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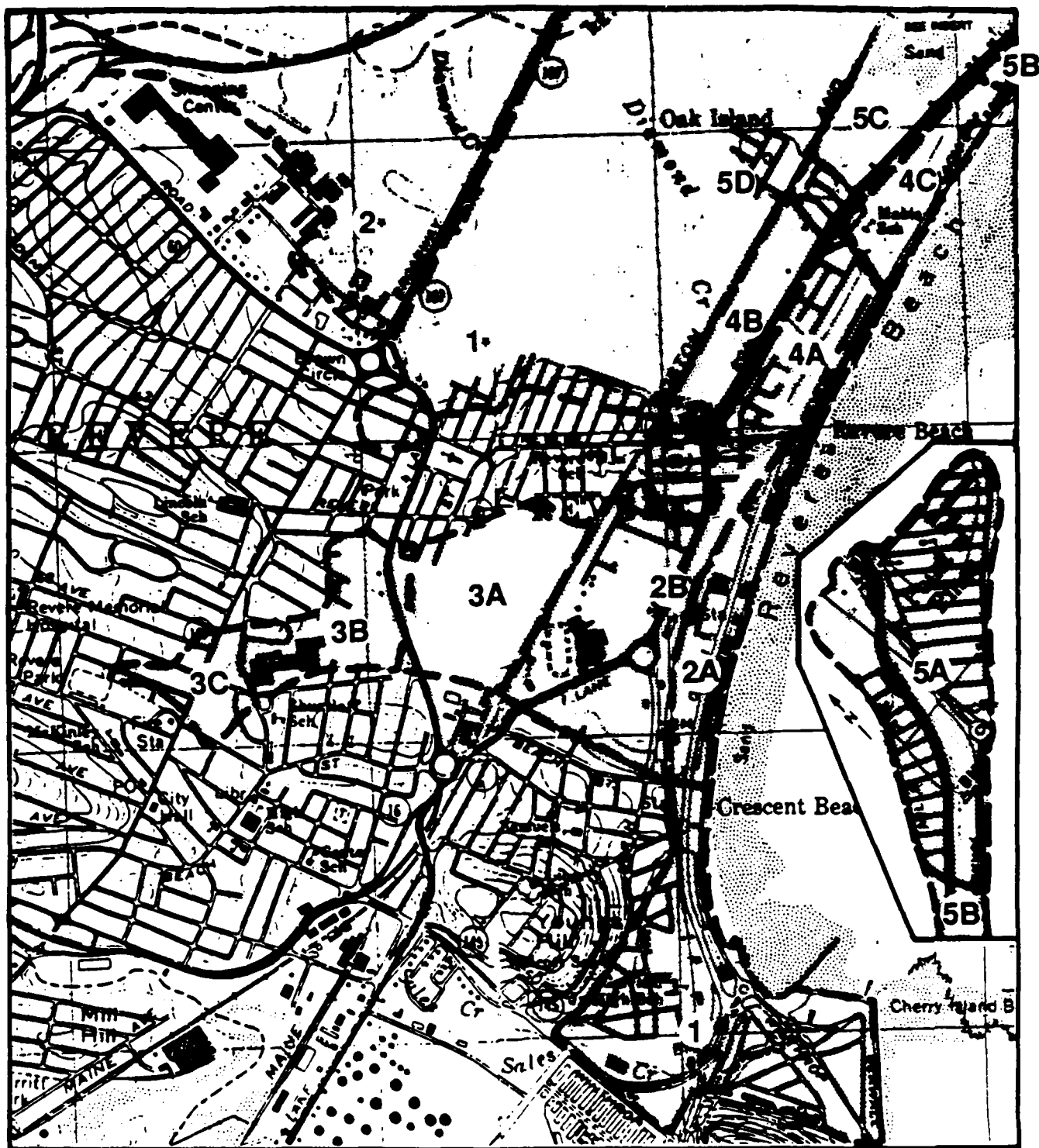
**FIGURE 5: CITY OF LYNN  
SPN FLOOD ZONES**

SOURCE: U.S.G.S. QUADRANGLE, LYNN

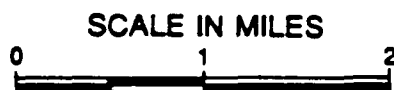
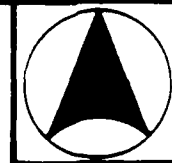


**FIGURE 6: TOWN OF SAUGUS  
SPN FLOOD ZONES**

SOURCE: U.S.G.S. QUADRANGLE, BOSTON NORTH AND LYNN



**FIGURE 7: CITY OF REVERE (NORTHGATE AREA) SPN FLOOD ZONES**



SOURCE:  
U.S.G.S. QUADRANGLE, BOSTON NORTH AND LYNN

**IEP** inc.

**(a) Historical and Existing Land Use**

One of the first uses of the Saugus River estuary was for the harvest of salt hay to feed cattle during colonial times. Wetlands were historically regarded as wastelands. The best possible use of a marsh or bog, it was believed, was to fill or drain it and use the land for agriculture or development. Some filling has occurred, though at a much slower pace since passage of the Wetland Protection Act in 1972 and its regulations in 1978 and 1983.

Land uses that displaced the estuary vary in their scope. Transportation uses are the most apparent. Route 107 and the Boston and Maine Railroad traverse the middle of the marsh. Even more obvious, is the embankment leftover from the abandoned Interstate 95. In the mid 1960's, plans were made to put Interstate 95 through the communities of Revere, Saugus and Lynn. However, Lynn and Saugus balked at the highway cutting through their neighborhoods and the plan was abandoned. Before it was stopped, however, over 8 million cubic yards of fill were dumped into the marsh.

Industrial uses in the wetlands include sections of the General Electric Plant. The exact date when this part of the marsh was filled is unknown. The RESCO plant in Saugus covers 13 acres and was built in 1975. The Northgate Shopping Mall in Revere is one of the commercial uses which was built in the early 1970's.

The marsh was often merely used as a waste disposal area. The Dematteo commercial landfill, which is adjacent to RESCO, covered 79 acres in 1954. From 1968 to 1973 it was licensed to fill more of the marsh and reached a total of 280 acres. According to the Environmental Protection Agency, the Dematteo Landfill was improperly licensed by the permitting agencies. An enforcement has been filed on the landfill since 1980, but no action has

been taken by the authorities. RESCO is licensed by the state to dispose of their ash at the Dematteo Landfill. Junkyards and auto related uses are also located near RESCO and at both ends of Route 107.

Residential uses surround the fringe of the marsh. The Oak Island neighborhood in Revere is composed of partial upland and partial fill. Major areas along the Upper Saugus River and Shute Brook have also been filled. These include the Riverside Cemetery and sections along Hamilton Street and Rhodes Street.

A major task undertaken to quantify the potential for new development in the study area was the Developable Lot Study. The results are shown on Tables 5, 6 and 7. The process involved tabulating each parcel as shown on the local assessor's sheets and determining its present use. Several thousand parcels were counted and sorted according to the State assessment land use code. Parcels were then grouped according to their location in the area (Corps 100-year flood zone or SPN). From these it was determined, based on assessor's records, which parcels were vacant. Of those, it was determined which were developable. It should be noted that the Assessor's offices in the different communities varied somewhat in their definition of developable.

### **Lynn**

The primary land use within the SPN delineation in Lynn is industry. Table 5 presents the actual land use in Lynn as determined through the Developable Lot Study.

Residential uses comprise the largest number of lots (50.6 percent), and industrial uses actually make up the greatest acreage at 307.5 acres, or 43.2 percent of the total.

**Table 5**  
**ACTUAL LAND USE: LYNN (1987)**

<b>Corps 100-Year Flood Zone</b>	<b>Number of Lots</b>	<b>%</b>	<b>Acreage</b>	<b>%</b>
Residential	290	40.6	34.10	4.42
Commercial	87	12.2	92.00	12.43
Industrial	48	6.7	297.90	42.04
Mixed Use	6	.8	.25	.04
Tax Exempt	101	14.2	137.80	19.07
Roads			108.00	14.95
Vacant	182	25.5	52.40	7.05
<b>TOTAL</b>	<b>714</b>	<b>100%</b>	<b>722.50</b>	<b>100%</b>

<b>SPN (incl. Corps 100-Year)</b>	<b>Number of Lots</b>	<b>%</b>	<b>Acreage</b>	<b>%</b>
Residential	472	50.6	52.10	6.22
Commercial	109	11.6	116.88	13.90
Industrial	52	5.6	307.50	36.74
Mixed Use	8	.8	1.90	.23
Tax Exempt	57	6.1	166.80	19.93
Roads			125.09	14.40
Vacant	237	25.3	66.77	7.98
<b>TOTAL</b>	<b>935</b>	<b>100%</b>	<b>836.99</b>	<b>100%</b>

### **Saugus**

In contrast to Lynn where every parcel on the assessor's maps was identified with a state property use code and subdivided into 4,500 to 5,000 square-foot parcels the area within the Saugus SPN was subdivided into smaller, 2,000 to 2,500 square-foot parcels. Buyers would purchase as many parcels as they needed. When adjacent parcels are owned by the same person, the assessor's office only identifies one of the parcels within a code. Therefore, it is not possible to determine with certainty the number of parcels and lots according to use. In such cases, the most rational location of the line was predicted in accordance with regional similarity. Actual land use is shown in Table 6.

Residential uses comprise a mere 9.68 percent of the total area within Saugus. Together, commercial, industrial and mixed use total 2.38 percent of the area. This is because the majority of the study area in Saugus is marsh, which is classified as vacant commercial developable land and tax-exempt (state-owned) land.

### **Revere**

The developable lot study in Revere revealed a greater amount of vacant land than expected in this densely developed city. Within the SPN, 482 acres of vacant land exists, as shown in Table 7. Nearly half of this vacant land is in the estuary, leaving 252 acres of vacant upland. Tax exempt lands comprise a large portion of Revere, due to state ownership of portions of the marsh and Revere Beach. Again, as in Saugus, the large acreage in the marsh dominates the total land uses and skews the percentages. Residential uses comprise only approximately 13 percent of the land use.

**Table 6**  
**ACTUAL LAND USE: SAUGUS (1987)**

<b>Corps 100-Year Flood Zone</b>	<b>Number of Lots</b>	<b>%</b>	<b>Acreage</b>	<b>%</b>
Residential	439	73.00	81.40	8.41
Commercial	19	3.00	13.10	1.33
Industrial	1	.04	9.50	.97
Mixed Use	3	.06	.40	.04
Tax Exempt*	11	2.00	215.90	22.34
Roads			144.00	15.00
Vacant*	96	16.00	495.43	51.28
Open Space	33	5.90	6.20	.63
<b>TOTAL</b>	<b>602</b>	<b>100%</b>	<b>965.93</b>	<b>100%</b>

<b>SPN (incl. Corps 100-Year)</b>	<b>Number of Lots</b>	<b>%</b>	<b>Acreage</b>	<b>%</b>
Residential	511	73.00	97.70	9.68
Commercial	21	2.90	13.50	1.35
Industrial	1	.14	9.50	.95
Mixed Use	3	.42	.80	.08
Tax Exempt*	22	3.14	220.20	21.81
Roads			153.54	15.11
Vacant*	105	14.98	499.73	49.51
Open Space	38	5.42	15.30	1.51
<b>TOTAL</b>	<b>701</b>	<b>100%</b>	<b>1,010.27</b>	<b>100%</b>

\* Includes Marsh

**Table 7**  
**ACTUAL LAND USE: REVERE (1987)**

<b>Corps 100-Year Flood Zone</b>	<b>Number of Lots</b>	<b>%</b>	<b>Acreage</b>	<b>%</b>
Residential	1018	60.10	97.30	13.47
Commercial	22	1.30	30.80	4.26
Industrial	18	1.16	6.10	.84
Mixed Use	8	.40	4.60	.64
Tax Exempt*	78	4.61	283.00	39.22
Roads			108.40	15.01
Vacant*	549	32.43	191.80	26.56
Open Space	0	0	0	0
<b>TOTAL</b>	<b>1,693</b>	<b>100%</b>	<b>877.00</b>	<b>100%</b>

<b>SPN (incl. Corps 100-Year)</b>	<b>Number of Lots</b>	<b>%</b>	<b>Acreage</b>	<b>%</b>
Residential	1695	58.03	180.30	12.67
Commercial	93	3.18	88.00	6.18
Industrial	38	1.30	41.20	2.89
Mixed Use	16	.55	5.70	.40
Tax Exempt*	220	7.53	445.40	31.30
Roads			180.4	12.68
Vacant*	859	29.41	482.15	33.88
Open Space	0	0	0	0
<b>TOTAL</b>	<b>2,921</b>	<b>100%</b>	<b>1,423.15</b>	<b>100%</b>

\* Includes Marsh

**(b) Plans for Development****Lynn**

For the past decade, the City of Lynn has aggressively pursued the revitalization of its residential and commercial neighborhoods. Major development projects include the Urban Heritage State Park, North Shore Community College, Waterfront Industrial Park and numerous downtown building conversions.

Focus has recently turned to developing large empty parcels of land within the community. Two of those projects are within the study area. Consultants have been hired by the City to study the parcels and determine their highest and best use. The report is not available to the public yet, but some initial findings can be reported.

One parcel is the South Harbor Planning Area. This 70-acre site, with 4,000 feet of water frontage, is one of the few remaining large waterfront development sites in Massachusetts. At one time a marine industrial park was proposed. This is no longer seen to be feasible due to the physical constraints of the site and an unfavorable market position.

Development of the South Harbor Planning Area has been constrained by the Lynnway with its heavy traffic volume and strip development. Separate sanitary and storm sewers would have to be built for any project. Consultants identified a mixed-use development as best for this site. This would include: residential, commercial, retail, and recreation.

The second area is the Gateway. The Gateway is located near the Fox Hill Bridge on the peninsula jutting into the Saugus River. This 32-acre site has 3,000 feet of frontage along the Saugus River. Potentially 220,000 square feet of building space could be built on this site.

### **Saugus**

Saugus is presently updating its master plan, which has not been revised since 1970. According to John Mahoney, Saugus Town Planner, the only plan for development in the study area is a 5,000 square-foot office building off Ballard Street.

The largest development plan within the Saugus study area is the potential commuter rail station on the Boston and Maine Railroad. A surface parking garage is planned for the station. Though this plan is in the preliminary stage, it has begun to increase interest in development in the East Saugus area.

### **Revere**

Of the three communities in the study area, Revere has experienced the most development. This is due to the marketability of expensive condominiums adjacent to Revere Beach. Presently, 24 condominium projects, containing a total of 3,233 units, have been proposed from Point of Pines to Ocean Pier.

Other proposed developments within the study area include an industrial park and city yard adjacent to the Northgate Shopping Center. A 54-unit townhouse development is proposed on Marshall Street near the Revere/Saugus border. Adjacent to the marsh is a 65-unit condominium project on Naples Street. Two major projects, adjacent to the Wonderland Dog Track and located in a filled marsh, are Renaissance Place (a 153-room hotel) and the Towle Manufacturing Company. Currently, Towle is building a \$23 million, 560,000 square-foot, light manufacturing plant which is expected to open in 1990.

**(c) Pressures for Development**

Factual indicators, such as building applications, subdivision approvals, zoning board of appeal rulings, and conservation commission orders of conditions, were discussed with local officials. Telephone calls and discussions with state and local officials, revealed no projects for development within the marsh. Most cited the Wetland Protection Laws as prohibiting such activities.

However, there were opinions expressed amongst local developers and residents that there is pressure to develop within the marsh environment. Residents of the Oak Island said that incremental, illegal filling of the marsh near them has occurred for years.

A realtor in Saugus said that people are holding onto their property in the flood plain in East Saugus waiting for "something" to happen. She said that the requirement to build above the flood level has discouraged some building in the area. However, she said a client who owns 38,000 square feet on Dustin Avenue, a "paper" street in East Saugus, just purchased an additional 97,000 square feet. She believed the only rational reason would be for development.

Violations of wetland filling is another indicator of the pressure for development. Since the adoption of the Administrative Penalties Act in 1986 in which the DEQE has authority to levy fines for violations of their environmental regulations, three cases in the estuary have totalled \$60,000 in fines. Two cases in Revere and one in Lynn have occurred as a result of the filling of salt marsh. Six other selected sites are currently under investigation (pers. comm., Ralph Perkins, Enforcement DEQE).

**(d) Barriers to Development**

**i) Regulatory**

**Federal:**

Three levels of regulation (federal, state, and municipal) govern activities in and around the project area. The following is a listing of existing and pending regulations and their impact on development.

**National Flood Insurance Program**

The National Flood Insurance Program (NFIP) was established by Congress in 1968. The program, administered by the Federal Emergency Management Agency (FEMA), provides subsidized flood insurance to property owners in participating communities. To qualify, local governments must adopt and enforce minimum flood plain management regulations in accordance with FEMA regulations and guidelines. If the municipal regulations comply with the Massachusetts Wetlands Protection Act (MGL ch. 131 s. 40) and Section 744 of the State Building Code, they will generally satisfy performance standards as established by FEMA.

Pursuant to the Flood Disaster Protection Act of 1973, any federal financial assistance related to new construction or substantial (greater than 50%) improvements of existing structures located in the 100-year floodplain is contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies, but also from federally insured savings and loan institutions. Thus, in order for property owners to be eligible for purchasing flood insurance, their respective community must be participating in the NFIP and in compliance with NFIP guidelines.

**Federal Permits for Discharges of Dredged or Fill Material Into the Waters of the United States (33 CFR Part 323)**

This regulation, amended November 1986, prescribes special policies, practices, and procedures to be followed by the Corps of Engineers (COE) in connection with the review of applications for Department of Army permits to authorize: 1) filling activities pursuant to section 404 of the Clean Water Act of 1977 as amended; 2) dams and dikes in navigable water pursuant to section 9 of the Rivers and Harbors Act of 1899; and, 3) certain structures or work in or affecting navigable waters pursuant to section 10 of the Rivers and Harbors Act of 1899. In effect, the COE and EPA has jurisdiction over nearly every waterway and wetland in the United States.

Although the COE has permitting authority and enforcement responsibility for those permits issued, the Environmental Protection Agency (EPA) has the ultimate enforcement authority for all wetlands under the guidelines set forth in section 404(b)(1) (see 40 CFR Part 230).

**State:**

**Massachusetts Wetlands Protection Act (MGL ch. 131 section 40)**

Within the salt marsh, fresh marsh, and flood plain of the study area, the most significant regulatory control is provided by the Massachusetts Wetlands Protection Act (WPA). Regulations under the Act are contained in 310 Code of Massachusetts Regulations 10.00 et seq. promulgated in August 1978 and implemented by the Department of Environmental Quality Engineering (DEQE). In 310 CMR 10.32 the regulations specify requirements relative to salt marshes. Most significantly they state:

"When a salt marsh is determined to be significant to the protection of marine fisheries, the prevention of pollution, storm damage prevention or ground water supply, the following regulations shall apply: (3) A proposed project in a salt marsh, on lands within 100 feet of a salt

marsh, or in a body of water adjacent to a salt marsh shall not destroy any portion of the salt marsh and shall not have an adverse effect on the productivity of the the salt marsh. Alterations in growth, distribution and composition of salt marsh vegetation shall be considered in evaluating adverse effects on productivity. This section shall not be construed to prohibit the harvesting of salt hay."

This regulation effectively precludes filling of the salt marsh, however, a variance procedure exists for public projects.

In April 1983, new regulations were adopted which allowed for the loss and replacement of up to 5,000 square feet of fresh marsh (i.e., Bordering Vegetated Wetland: 10.55). This regulation, in addition to a DEQE decision in a Saugus case (File # NE67-142, Cicolini), has potential ramifications in the Saugus and Pines River estuary because of the large expanse of Phragmites that borders the upland edge. Filling of Phragmites marsh may be allowed and the loss of flood storage capacity may not have to be compensated for since the estuary is subject to coastal storm flowage.

Also, in November 1987, wildlife habitat was added as an eighth interest of the WPA. The significance of this relates to the additional protection of areas within the 10-year flood plain that serve as vernal pool habitats.

Concerning other administrative aspects of how the WPA is working in the study area, interviews with regional and Boston DEQE staff portray a frustrating history of incremental and repetitive filling violations coupled with the lack of manpower and resources to better enforce the regulations. A position was funded in 1986 for enforcement personnel and is renewed on a yearly basis, but the regional responsibility extends far beyond the Saugus/Pines River estuary. Despite the regulatory program controls, the impression was that violations will continue to occur.

**Coastal Restriction Act (MGL ch. 130 section 105)**

The Saugus Marsh has been under consideration for this program which would establish deed restrictions on most construction activity within the salt marsh. The area was photographed and wetlands were delineated in 1978, however, owner research and program implementation did not occur. Program priorities were focused on Cape Cod and the Saugus River was not investigated any further. Lack of state funding has been a barrier to its inclusion ever since.

A \$5 Million program for completing the restrictions in 48 communities which have mapping products is currently in the Governor's FY'89 budget. In all probability, restriction of the salt marsh within the Saugus and Pines Rivers estuary would occur by 1993 and even sooner if there were a funding contribution from a local or federal agency (pers. comm. Christie Foote-Smith, DEQE).

**Minimum Requirements for Subsurface Disposal of Sanitary Sewage (Title V, State Environmental Code)**

Severe limitations (minimum setbacks from wetlands and watercourses) exist for the installation of septic systems near the marsh. However, with the availability of sewers in all three communities, this regulation may not be considered a significant barrier. Notwithstanding sewer availability, it is also costly to excavate peat and fill with suitable material to achieve the necessary four-foot separation from ground water.

**Waterways Licensing Provisions (MGL ch. 91)**

This law grants the state authority to license any project within present and known historical tidelands (below high water). A requirement that a proper public purpose is being served restricts the development of all "non-water dependent" uses.

Over 200 licenses have been issued under this authority for Saugus and Pines Rivers and Bear and Diamond Creeks. The majority of these allow for piers, docks, wharves and dredging; however, the licensing of the Dematteo fill in 1968, which then became irrevocable in 1973, was for non-water dependent uses. Proposed dredging of the Saugus and Pines Rivers has recently raised concerns about the potential for more growth and development related to water dependent uses.

**Massachusetts Environmental Policy Act (MGL ch. 30 s. 61-62H)**

The regulations (301 CMR 11.00) newly effective in January 1987, provide a uniform system for compliance with MEPA and provide for environmental review of major projects undertaken by state agencies, financed by state agencies, or requiring permits from state agencies.

Under section 11.25, projects of the following types or sizes, and needing any agency action or permits require both an Environmental Notification Form (ENF) and an Environmental Impact Report (EIR):

- (2) Any project resulting in the dredging, filling, alteration or removal of one or more acres of bordering vegetated wetland or salt marsh, or ten or more acres of any other resource are protected by the Wetlands Regulations (310 CMR 10.00) excluding the buffer zone.
- (4) Any project requiring a Ch. 91 license for non-water dependent use of one or more acres of tidelands.
- (12) Construction of any new rapid transit line on a new right-of-way; extension or abandonment of an existing rapid transit line.

Under section 11.26, projects above other thresholds just require an ENF. One wetlands threshold [(7)(a)3.a.] is the issuance of a DEQE Superseding Order of Conditions for permitting any dredging, filling, altering or

removal of 1,000 square feet or more of salt marsh or 5,000 square feet of bordering vegetated wetland. Also, an ENF is required for any project proposed in an ACEC (301 CMR 11.15).

#### **Areas of Critical Environmental Concern (ACEC)**

Areas of Critical Environmental Concern (ACEC) in Massachusetts are regulated under 301 CMR 12.00 and are primarily large wetland systems bordered by relatively undeveloped upland. Designated for the purpose of protecting natural wetland values, these areas generally have an upland boundary located along the 100-year flood plain elevation. Any proposed activity which involves dredging, filling, removing or altering the ACEC receives greater public attention than what the normal permitting process would require and, in fact, may need to be justified by an Environmental Impact Report.

In the Spring of 1988, the Broad Sound ACEC Nominating Committee submitted a proposal to the Secretary of Environmental Affairs to have portions of the Broad Sound, Saugus and Pines Rivers, and portions of the cities of Boston, Revere, Lynn, Saugus and Winthrop designated as an ACEC. The nomination was accepted on 1 April 1988 and public information meetings were suggested to provide an opportunity for discussion of the reasons for nomination, ramifications of designation, and administrative procedures involved in the designation.

The proposed ACEC as it relates to the SPN area includes the entire 1,700 acres of tidal wetlands in the Saugus and Pines Rivers estuary, but also upland areas in East Saugus as well as Point of Pines and the entire beach and developed areas behind the beach in Revere.

**Municipal:**

The following is a condensation, community by community, of specific municipal regulations affecting development in the study area. Local zoning and other regulatory controls will have a great impact on future land use within the SPN. A number of properties will be protected from further regulation by the "grandfathering" protections of MGL ch. 40A s. 6.

**Lynn:****Subdivision Control:****Section L. Flood Plain District**

All subdivision proposals shall be reviewed to determine whether such development will be reasonably safe from flooding. If any part of a subdivision proposal is located within the Flood Plain District established under the Zoning Bylaw, it shall be reviewed to assure that:

1. The proposed subdivision is designed consistent with the need to minimize flood damage, and
2. All public utilities and facilities, such as sewer, gas, electrical, and water systems shall be located and constructed to minimize or eliminate flood damage, and
3. Adequate drainage systems shall be provided to reduce exposure to flood hazards, and
4. Base flood elevation (the level of the 100-year flood) data shall be provided for proposals greater than fifty (50) lots of five (5) acres whichever is the lesser, for that portion within the Flood Plain District.

**Revere:****Zoning Ordinances**

- 17.12.030. Uses are allowed in the Flood Plain in accordance with the underlying zoning.
- 17.08.290. Defines "Flood Plain" as that shown as the 100-year flood zone on the FEMA maps.
- 17.16.240. Any filling or excavation not related to building construction requires a special permit from the City Council.
- 17.16.280. Retaining walls require approval of the City Engineer.
- 17.46. Flood Plain District Regulations.

**Subdivision Control.**

The rules and regulations governing the subdivision of land in Revere have standard provisions for drainage and drainage easements. There are no special provisions for construction within the flood hazard areas.

**Saugus:****Zoning Bylaws**

Two zoning districts in Saugus govern land use in flood hazard areas:

- 4.6A. Flood Plain District; Lands shown as Floodway on the FEMA Flood Boundary and Floodway Map dated January 19, 1983, as amended, and lands shown as Flood Plain on the official Zoning Map of the Town of Saugus, as amended.

**Permitted uses:**

- o Facilities for essential services (streets, drains, bridges, etc.)
  - o Private Utility, Transmission Lines, Sub-station or Similar Facility or Building (special permit - Selectmen)
  - o Agriculture, Nurseries, Forest, etc.
  - o Temporary events such as fairs and circuses
  - o Accessory signs (special permit - Board of Appeals)
- (Generally, no construction of retail or residential structures is allowed in the Flood Plain District)

4.6 B. Lands in Saugus shown as Zones A, A-2, A-3, A-4, A-7, and A-9 on the Town of Saugus Flood Insurance Rate Map dated January 19, 1983, as amended, except for those which are included in the Flood Plain District as defined in Section 4.6 A above.

**Permitted Uses:**

Same as the underlying zoning districts. This district is distinguished to control the construction of buildings and placement of fill in the district (not to govern use).

Section 6.5 Building in Flood Plain Districts. This is the local requirement for building construction in the FEMA A-Zone and Floodways.

Section 9.1 Non-conforming Uses, Structures and Lots. The preamble to this section states, "It is the purpose of this Bylaw to discourage the perpetuity of nonconforming uses whenever possible."

Section 9.3 Essentially similar to protections granted in MGL ch. 40A 6 relative to undersized lots.

Section 9.4 Regarding the restoration of damaged or destroyed buildings, there is no mention of bringing the restored building into compliance with flood district requirements.

Section 12.4.B. Special Permits for Flood Plain District. It is not clear whether this includes the Flood Plain-Fringe. This section puts strict guidelines on construction within this district.

**Subdivision Control.**

The rules and regulations governing the subdivision of land in Saugus have standard provisions for drainage and drainage easements. There are no special provisions for construction within the flood hazard areas.

Zoning is not presently a deterrent to construction in the marsh areas of Saugus and Revere because both municipalities have zoned the marsh area for industrial development.

Permitted by right in the Town of Saugus in their industrial district are the following: single family homes, retail stores, offices, restaurants, and motels. Allowable by special permit are: light manufacturing, disposal of waste material and refuse, warehouses, automobile sales and repair, automobile salvage yards and other related industrial activities. Saugus has zoned a portion of the marsh as Flood Plain District. No uses are allowed in the Flood Plain District other than golf courses, drainage facilities, bridges, utilities, farming, signs and recreational facilities.

In Revere, all uses (except class II automobile sales) are allowed in the Industrial District. According to the City of Revere Growth Management Plan, dated June 15, 1987, "Revere's zoning still reflects the land use principles of the 1920's and early 1930's." This plan recommends the city "rezone the major tidal wetland systems (Pines River and Belle Isle) from industrial to wetlands/conservation."

#### **Other Local Control**

Additionally, the local communities have wetlands bylaws which place greater restrictions on wetland development than DEQE regulations. The most significant constraint associated with such bylaws is the necessity of appealing a decision under these bylaws to Superior Court. This is generally far more expensive than the appeal process through DEQE (which also must be undertaken).

Implementation of the Wetland Protection Act and the local wetland bylaws in Saugus and Revere are similar in that Orders of Conditions are issued prior to the issuance of a building permit by the Building Inspector. In Saugus,

two part-time inspectors manage day to day conservation and enforcement business. In Revere, a consultant assists the commission with a case-by-case review. Currently, an additional one-foot in elevation is required above the flood plain elevation for proposed dwellings in Revere (pers. comm. Arthur Vulgaropolis, Consulting Engineer). Also, flood storage compensation is being required which exceeds the state requirements. Nonetheless, local frustration was expressed with less restrictive superseding orders that have been issued by DEQE.

#### **ii) Topographic Constraints**

Low-lying topographic features, such as wetlands and flood plains, are physical constraints to development in most coastal communities. Developing these areas typically requires any of the following: excavating peat, taking the peat off site, bringing in suitable soils or, elevating homes on fill or flood proofing the lower floors. These activities require environmental permits, special construction methods and building designs and maintenance costs not required in topographically high areas. The overall effect of these barriers may translate into a landowner either waiting until the physical conditions change or until a combination of other changes occur that justify the investment of time and money to develop. With the exception of a topographic high, Bakers Hill, in Saugus near the Revere line, low-lying areas of wetlands and flood plain dominate the approximate 11.5-mile estuarine shoreline. And if one considers the additional land along Route 107 and the Dematteo property, the shoreline would be twice that. However, the extensive history of filling in the marshes of Lynn, Saugus and Revere can lead one to question the effectiveness of wetlands and flood plains as physical constraints to development.

## **Wetlands**

Prior to 1950, large-scale filling in Lynn had occurred with the development of the General Electric plant. Between 1950 and the mid-1970's, the remaining large-scale filling had occurred in Saugus with the I-95 embankment, the Dematteo Landfill, and RESCO plant. In addition, a large dredging and marsh removal area (Seaplain Basin) resulted near Town Line Brook at the southwest corner of the Pines River in Revere. Historically, over 200 Chapter 91 Waterways licenses allowing fill and dredge projects have been granted within the estuary.

Filling of the marsh along its periphery, rather than in the interior portions, continues but at a slower rate than in the past. A change analysis was conducted to qualitatively identify wetlands that have recently been filled using 1978 orthophotography completed for the Massachusetts Department of Environmental Management and 1987 color infrared photos taken for the Corps of Engineers. Five areas in Lynn, nine areas in Saugus, and nine areas in Revere were identified as recent fill within the estuary. While these areas have not been measured by ground survey and a detailed assessment has not been made, the most distinct changes have occurred in areas of restricted tidal flow, vegetated by Phragmites australis.

Phragmites is an "invader" species which creates a complicated and often indistinguishable marsh/upland boundary making it easier for filling to occur. In addition, this species is regulated somewhat differently within the state and federal wetland programs. Under state law, Phragmites is primarily regulated as an inland wetland species rather than a salt marsh species. Thus, filling is likely to be conditioned rather than denied. Under federal law this distinction has not been made, therefore, both fresh and salt marshes are regulated similarly.

## **Flood Plain**

Adjacent to the wetlands in the estuary, the 100-year flood plain is currently regulated at elevations between eight and ten feet mean sea level (MSL) as mapped by FEMA. The Corps, however, has more detailed information for the flood zones within Lynn, Saugus, and Revere. The Corps elevations around the estuary are generally higher ranging from .2 to 2.2 feet with the exception of Zones 4B and 4C in Revere (Table 8).

Between 1978 and 1984, FEMA collected available information in Revere, Lynn and Saugus as a basis for determining flood plain levels and insurance ratings. At that time, the Corps provided FEMA "unpublished and preliminary" information for Revere and Lynn from scant data available to estimate the 1978 and other flood levels.

The Lynn Flood Insurance Study (FIS) was published by FEMA using the preliminary information along the Saugus River provided by the Corps. Other available information and analyses were used along the coast to estimate flood levels.

The Saugus FIS was published by FEMA in 1982 and flood levels reflect hydraulic analyses and available information at that time.

The Revere FIS was published in 1984. Flood levels published behind Revere Beach were based on "preliminary and unpublished" information provided by the Corps.

In 1984 the Corps recognized significant discrepancies in the flood levels reported by residents along the Pines and Saugus Rivers. To resolve the discrepancy, gaging stations were installed by the USGS in Broad Sound and on the Saugus and Pines Rivers to record tide levels and calibrating tides in the study area with the 130 years of records in Boston Harbor. The data

**Table 8**
**100-YEAR FLOOD ELEVATIONS  
ADJACENT TO TIDAL MARSH AREAS**
**LYNN**

<u>Flood Zone</u>	<u>CORPS (1988)</u>	<u>FEMA (1984)</u>
1 - Lynn, Harbor Coastal Area	12.4	12.0/11.0
2 - Lynn General Electric Area	11.2	9.0
3 - Lynn, Saugus and Little Rivers Area	10.3	8.0
4 - Lynn, Saugus, River - B & M Tracks to Boston and Summer Street	10.3	8.0

**EAST SAUGUS**

<u>Flood Zone</u>	<u>CORPS (1988)</u>	<u>FEMA (1982)</u>
1 - Saugus River to Ballard Street	11.0	10.0
2 - Between Ballard and Bristow Street	10.7	10.0
3 - Saugus Marsh to Bristow Street	10.5	10.0

**NORTH GATE**

<u>Flood Zone</u>	<u>CORPS (1984)</u>	<u>FEMA (1984)</u>
Zone 1 and 2	10.7	9.0

**REVERE**

<u>Flood Zone</u>	<u>CORPS (1988)</u>	<u>FEMA (1984)</u>
3A-C - Towle, High School, Broadway	6.2	6.0
4A - Kelley's Meadow	8.3	8.0
4B - B & M Railroad	6.5	7.0/9.0
4C - Revere House	7.7	8.0
5B - Revere Beach Bld to Rt. 1A	10.3	9.0
5A, C, D - Riverside and Pines River	10.3	9.0

was used to develop a numerical hydrodynamic model of tides in the study area. The 1986 report (CERC 86-8), by the Corps Waterways Experiment Station, is currently the best available information on the tides in the study area. Between 1986 to 1988 extensive interviews by the Corps were conducted in Lynn and Saugus and completed in Revere to collect historical high water information. The results of modeled tide levels and historical information were provided for this 1988 report.

Future conditions without the federal project will mean that FEMA, by law, must review the updated Corps data and change the mapping for Lynn, Saugus and Revere accordingly (Ed Thomas, FEMA, pers. comm. 3/28/88). As a consequence, there may be an increase in the area of regulatory jurisdiction.

The extent of increased flood plain varies as a function of elevation differences (between FEMA and Corps data). In Lynn, for example, an elevation change of 2.3 feet over a .5 percent slope results in a 500-foot landward increase around the General Electric Plant. In Saugus, an elevation change of 1.0 feet over a .09 percent slope results in an 1,100-foot landward increase in the Ballard Street arear. In the Northgate section of Revere, an elevation change of 2.0 feet over a 1.3 percent slope results in a 150-foot landward increase.

### **iii) Flood Plain Construction Costs**

The total costs of elevating residential structures in coastal high hazard areas depend upon numerous factors (FEMA-55, 1986). "Discussions with builders and local officials revealed that the additional cost to elevate a structure over the cost of at-grade construction can be expected to be between \$1.30 and \$5.10 per square foot. This additional cost was also determined to vary with the size of the structure, with higher additional unit (square foot) costs being associated with larger structures."

In the FEMA flood zone, houses are usually set up on fill with crawl-space foundations or built on pilings. It can be generalized that few structures in this area will be set on pilings. Pile structures are extremely expensive and generally considered unsightly. The rule of thumb in the industry for pilings is \$1,000 per pile, with the average house requiring 20 to 40 piles. Added to this are several thousand dollars in additional structural engineering costs. These foundations are appropriate where wave encroachment under the house is imminent or where the ground is in flux, such as on sand (FEMA 1986).

If construction is to be on fill, the additional costs are less. In general, fill trucked to the site costs \$60 to \$80 per 15-cubic yard load. To raise a 1,000-square foot structure 3 feet requires 110 cubic yards or 8 truckloads - approximately \$600 dollars. Grading costs will add this much or more to the operation. Stated another way, fill costs approximately 20 cents per square foot per foot raised: less than one-half of one percent for a \$150,000 home.

A significant additional cost to construction is excavation of unsuitable material and fill required to stabilize structures built on previously filled marsh land. This land will have a subsurface layer of dense peat many feet deep, which is considered unsuitable for construction stability, especially with larger structures. According to civil engineers, the proper approach to this situation is the removal of the peat layer and replacement with a sandier fill material. As an example, a 12-foot deep excavation and replacement operation for a single-family house with a 1,000-square foot land coverage will cost between \$15,000 and \$25,000, according to several local contractors.

It is important to note that this last cost would be incurred regardless of flood plain regulation.

In conclusion, flood plain regulations do not prevent building within a flood zone. They place additional burdens on structural and excavation design. Because of this, a greater amount of fill and excavation is required near the wetland resources.

#### **iv. Other Factors Restricting Development**

A significant cost, considered a "soft" cost, is that of permitting in a flood zone area, especially within 100 feet of a wetland resource. A lawyer working for an engineering firm stated, "A residential project within the Conservation Commission's jurisdiction will have added costs totalling between two and ten thousand dollars. A commercial project of any substantial nature can expect between ten and thirty thousand additional dollars." This was due to the higher informational quality of plans required, environmental consulting and municipal board representation costs. In many cases, the time required to complete permitting becomes a very substantial cost, if not an outright bar, to construction activities.

Without exception, however, everyone contacted in the development business said that the economy, interest rates, and the market had more to do with their decisions to undertake construction projects within the study area than the additional costs added by flood plain regulation.

### **(e) Future Development Without a Federal Project**

Future land use in the study area depends on a number of factors: existing land use, amount of vacant land, the community's zoning and subdivision regulations, and economics.

The developable lot study provided information on the amount of vacant land in the study area. From this information, the potential minimum build-out, that is the potential for the minimum number of additional buildings, could be determined.

The amount of vacant land available for development in the study area varies in each community. Lynn has a total of approximately 67 acres of vacant land. However, only 43 acres has been coded by the assessor's office as "developable land" (Table 9). The remaining vacant land has been determined to be "potentially developable" or "undevelopable." Only developable land will be used in this section to determine the amount of future development. It will be assumed that if land has been coded as developable by the assessor's office, it is. It is also assumed that undersized but protected lots (greater than 5,000 square feet with a minimum of 50 feet of frontage) are eligible for building permits for residential construction (according to Chapter 40A, section 6), and that all parcels will conform to Title V or municipal sewer standards.

Saugus appears to have about 496 acres of vacant developable land, but this total includes 457 acres of the marsh (Table 10). Parcels in the marsh are coded as developable land by the Saugus Assessor's Office. Excluding vacant land in the marsh, there are approximately 38 acres of vacant developable land, all of it coded as residential land.

**Table 9**

**VACANT LAND: LYNN (1988)**

<b>Corps 100-Year Flood Zone &amp; Below</b>	<b>Property Class Code</b>	<b>Number of Lots</b>	<b>Acres</b>
Residential	Developable 130	41	5.10
	Potential Dev. 131	10	2.40
	Undevelopable 132	14	2.40
	SUBTOTAL	65	9.90
Commercial	Developable 390	29	8.40
	Potential Dev. 391	41	13.70
	Undevelopable 392	1	.07
	SUBTOTAL	71	22.17
Industrial	Developable 440	40	19.10
	Potential Dev. 441	5	1.20
	Undeveloped 442	1	.01
	SUBTOTAL	46	20.31
<b>GRAND TOTALS:</b>		<b>182</b>	<b>52.38</b>

<b>SPN Including Corps 100-Year</b>	<b>Property Class Code</b>	<b>Number of Lots</b>	<b>Acres</b>
Residential	Developable 130	44	8.00
	Potential Dev. 131	17	3.00
	Undevelopable 132	20	3.30
	SUBTOTAL	81	14.30
Commercial	Developable 390	40	10.60
	Potential Dev. 391	50	14.90
	Undevelopable 392	2	1.37
	SUBTOTAL	92	26.87
Industrial	Developable 440	53	24.40
	Potential Dev. 441	5	1.20
	Undeveloped 442	1	.01
	SUBTOTAL	59	25.61
<b>GRAND TOTALS:</b>		<b>232</b>	<b>66.78</b>

**Table 10**
**VACANT LAND: SAUGUS (1988)**

Corps 100-Year Flood Zone & Below	Property Class Code	Number of Lots	Acres
Residential	Developable 130	70	33.70
	Potential Dev. 131	0	0
	Undevelopable 132	0	0
	SUBTOTAL	70	33.70
Commercial	Developable 390	20	457.00*
	Potential Dev. 391	1	.10
	Undevelopable 392	4	4.20
	SUBTOTAL	25	461.30
Industrial	Developable 440	1	.43
	Potential Dev. 441	0	0
	Undeveloped 442	0	0
	SUBTOTAL	1	.43
GRAND TOTALS:		96	495.43

SPN Including Corps 100-Year	Property Class Code	Number of Lots	Acres
Residential	Developable 130	79	38.00
	Potential Dev. 131	0	0
	Undevelopable 132	0	0
	SUBTOTAL	79	38.00
Commercial	Developable 390	20	457.00*
	Potential Dev. 391	1	.10
	Undevelopable 392	4	4.20
	SUBTOTAL	25	461.30
Industrial	Developable 440	1	.43
	Potential Dev. 441	0	0
	Undeveloped 442	0	0
	SUBTOTAL	1	.43
GRAND TOTALS:		105	499.73

\* Includes Marsh

Revere has nearly 156 acres of developable vacant land (Table 11). Unlike Saugus, Revere classified parcels within the marsh as undevelopable land. The majority of this land is coded as vacant commercial land.

Altogether (excluding vacant land in the marsh), there is a total of about 237 acres of developable vacant land in the SPN. Of these acres, 160 are in the Corps 100-year flood zone. This developable acreage is divided into 588 lots in the entire SPN. The Corps 100-year flood zone contains 383 of these lots. At the minimum, 588 additional buildings could be built in the SPN on these vacant parcels. Potentially, there could be more buildings than these if the larger parcels were subdivided.

These estimates do not take into account conversions of pre-existing, non-conforming structures or the replacement of existing structures with more intensive uses such as multi-story buildings. The number of conversions and "replacement" buildings will be determined by economic factors.

Trends in development since 1982 were assessed by comparing the number of building permits issued for new residential construction in the three communities. Table 12 compares the number of building permits issued for new residential construction. Single family and multi-family units were counted rather than the number of buildings in order to demonstrate the intensity of development. Commercial and industrial permits were not counted because that development has been too sporadic in the municipalities.

Table 15 shows permits have increased in all the communities since 1981. The most dramatic increase has been in Revere. Permits for 58 units were issued in 1982 and increased to 641 in 1987, a 1005 percent difference. Saugus had a 66 percent difference and Lynn, 110 percent. While the change in Saugus has not been dramatic, it has been steady and strong.

**Table 11**
**VACANT LAND: REVERE (1988)**

Corps 100-Year Flood Zone & Below	Property Class Code		Number of Lots	Acres
Residential	Developable	130	157	34.81
	Potential Dev.	131	6	.69
	Undevelopable	132	282	56.54
	SUBTOTAL		445	92.04
Commercial	Developable	390	34	10.50
	Potential Dev.	391	6	.20
	Undevelopable	392	65	234.20*
	SUBTOTAL		102	245.90
Industrial	Developable	440	2	8.88
	Potential Dev.	441	0	0
	Undeveloped	442	0	0
	SUBTOTAL		2	8.88
GRAND TOTALS:			549	346.82

SPN Including Corps 100-Year	Property Class Code		Number of Lots	Acres
Residential	Developable	130	205	40.07
	Potential Dev.	131	6	.35
	Undevelopable	132	475	55.36
	SUBTOTAL		686	95.78
Commercial	Developable	390	103	106.76
	Potential Dev.	391	7	7.16
	Undevelopable	392	60	234.20*
	SUBTOTAL		170	348.12
Industrial	Developable	440	3	9.00
	Potential Dev.	441	0	0
	Undeveloped	442	0	0
	SUBTOTAL		3	9.00
GRAND TOTALS:			859	482.15

\* Includes Marsh

**Table 12**  
**BUILDING PERMITS FOR NEW HOUSING UNITS**

Town	Total Existing 1980 Housing Units	1982	1983	1984	1985	1986	1987	Percent Increase From 1982 to 1987	Total Number of New Units
		58	138	329	570	635	641		
Revere	17,176	121	98	196	170	212	201	1,005 %	2,371
Saugus	8,307	214	164	127	337	289	450	66 %	998
Lynn	32,617							110 %	1,581

Source: Housing Units Authorized by Building Permits and Public Contracts:  
Annual 1982-1987, U.S. Department of Commerce, Bureau of the Census  
U.S. Census, 1980.



Interviews with realtors and developers provided a mixed forecast on potential future development in the study area. Development will continue in the study area as long as it is economical. The recent downturn in the housing market has slowed the sale of condominiums in the Revere Beach area.

Future development in the marsh is precluded by the Wetlands Protection Act. The success of this regulation will be dependent on the various communities efforts and abilities to enforce the restrictions. Most of the marsh is zoned industrial, except for a portion in Saugus that is zoned flood plain. Revere is in the process of updating its zoning regulations. The Planning Department is proposing changing the zoning in the marsh from industrial to wetlands/conservation.

If the total number of new units are taken as a percentage of the existing units in 1980, Saugus appears to have experienced nearly as much residential growth as Revere. The 998 new units permitted from 1982 to 1987 would be a 12 percent increase over the total 8,307 units in 1980. Revere's new units (2,371) are a 13.8 percent increase from the 1980 total. Lynn has a much lower rate with 1,581 units, only equalling a 4.8 percent increase over 1980.

Whether these development trends will continue will depend on a number of factors: continued demand for housing in the study area, interest rates, health of the local and regional economy, and housing inventory in the regional market. Median housing prices have dropped in the Boston area for a second quarter in a row, the first time this has happened in the seven years the Greater Boston Real Estate Board has been tracking the number (Boston Globe, 1988). One reason for the drop in prices is the glut of housing on the market. More housing and different types of housing are available to buyers in the Boston region than in the past. Many communities have built faster than demand. Revere is cited as one area where the condominium market is over built (Boston Globe, 1988).

**b) Property Values and Housing**

A comparison of housing characteristics between the study area, the four communities and the Boston Standard Metropolitan Statistical Area (SMSA) from the 1980 Census discloses some differences (Table 13). Information for the study area was obtained from a demographic company, CACI, Inc. (CACI). From a USGS map delineated with the study area, CACI provided demographic information for the study area. The four communities information was combined.

There are differences in housing characteristics between the study area and the communities. There is a higher percentage of vacant units and renter occupied units in the study area. Vacant units include units for sale or rent, seasonal, occasional use, or those abandoned. It is the greater number of seasonal/occasional use units in the study area that pushes the percentage of vacant units higher in the study area.

Median housing value was lower in the study area than for the communities. In turn, the communities median housing value in 1980 was lower than in the Boston SMSA. This remains true to a certain extent today. For example, a single family home with a small basement apartment in Revere is \$151,000, while in the Boston area it would be valued at \$175,000 (City of Revere Growth Management Plan, 1987).

Neighborhoods within the study area command lower housing prices than other areas within their communities. This is due to the high amount of substandard and deteriorated housing. A unit is substandard when it either has inadequate cooking or plumbing facilities. Most of the housing sections within the Lynn study area are classified as marginal in terms of marketability by Lynn Department of Community Development. A marginal area is one where deterioration is highly visible yet substantial rehabilitation is feasible (City of Lynn Open Space and Recreation Plan, 1984). In Revere,

**Table 13**  
**HOUSING CHARACTERISTICS AND PROPERTY VALUES, 1980**

	Total Housing Units	Percent Occupied Units	Percent Vacant Units	Percent Owner Occupied Units	Percent Renter Occupied Units	Median Housing Value	Gross Median Rent
Study Area	8,339	93.5%	6.5%	48.4%	51.6%	\$41,991	\$256
Communities	79,564	96.5%	3.5%	51.8%	48.1%	\$46,900	\$271
Boston SMSA	1,043,715	95.2%	4.8%	53.2%	46.8%	\$58,700	\$281

Source: 1980 Census

approximately 40% of the housing units in the city are classified as substandard and deteriorated housing (Demographic Profile, 1983). Housing in the eastern section of Saugus also has a high rate of substandard units.

Housing prices within the communities have increased substantially in the past few years as has the rest of eastern Massachusetts. In Revere, for example, a house valued at \$41,000 in 1977 would now be valued at \$151,000, a 368% increase (City of Revere Growth Management Plan, 1987). Speculation in the communities has increased as homebuyers in the region take advantage of the area's lower housing prices. According to a realtor at Carlson Real Estate in Saugus, housing demand has moved from Boston to East Boston and northward to Malden, Revere, Saugus, and Dedham and has bypassed Lynn and progressed to Peabody. Table 14 shows the percentage increase in housing properties within the four communities from the fourth quarter in 1984 to the third quarter in 1987. Revere has experienced the greatest increases in prices, especially for condominiums. As mentioned previously, however, the condominium market in Revere has slowed due to overbuilding which has depressed prices.

**Table 14**

**MEDIAN HOUSE AND CONDOMINIUM PRICES**

	<b>LYNN</b>	<b>SAUGUS</b>	<b>REVERE</b>	<b>MALDEN</b>
House Prices 4th Quarter 1984	\$ 80,000	\$ 87,000	\$ 85,900	\$ 95,000
House Prices 3rd Quarter 1987	<u>\$140,000</u>	<u>\$154,000</u>	<u>\$165,000</u>	<u>\$160,000</u>
Percentage Increase	75%	77%	92%	68%
Condo Prices 4th Quarter 1984	\$ 65,000	\$113,434	\$ 46,900	\$ 55,900
Condo Prices 3rd Quarter 1987	<u>\$122,000</u>	<u>\$176,500</u>	<u>\$132,300</u>	<u>\$115,500</u>
Percentage Increase	88%	55%	182%	106%

Realtors, with their daily contact within the housing market, provide an excellent barometer for demand and knowledge of the community. Realtors differ on how flooding affects property values and the housing market. A Century 21 Hub Realty realtor in Revere said that people are buying homes in the Point of Pines and Oak Island neighborhoods despite flooding problems. Some buyers are deterred, but on the whole it is not a problem since the comparatively low prices for homes near the ocean still makes them attractive. Because of beach access, these neighborhoods are becoming more popular.

On the other hand, a realtor at Jaguar Realty said that some buyers shy away from Point of Pines and Oak Island because of problems with dampness. Buyers perceive those areas as being within the wetlands. She said that areas around the marsh are not seen as desirable places to live.

East Saugus is also becoming a more attractive place to live. According to a Realtor at Carlson Real Estate, some people like living on the marsh for views of Boston and the open space. Also, the possibility of a commuter rail station in East Saugus is increasing interest in the area.

In Lynn, a realtor at Hughes Realty said a lot of building was going on anyway despite flooding problems. Developers are just building differently. According to the realtor, it is not that much more expensive to build for flooding. However, a realtor at John Conner Real Estate said flooding is of some concern and is a detraction to the area.

### **c) Business and Industrial Activity and Regional Growth**

Within the study area, only the City of Lynn has significant industrial activity. Half (48.5 percent) of the study area in Lynn is used for industry. Manufacturing operations comprise nearly all of the industrial activity. The General Electric plant is the largest manufacturing plant in Lynn.

Industry in Revere and East Saugus is almost non-existent. Each community has only one major industrial site; the Towle Manufacturing Company in Revere and the RESCO plant in Saugus.

It is important to note that all three of the major industrial activities in the study area are located in filled wetlands (General Electric, Towle Manufacturing and RESCO). Since the majority of the estuary is zoned for industrial use, there is some pressure for it to be used for industrial purposes.

Business activity in the study area is primarily devoted to wholesale and retail trade and service establishments. Trade and service employment has the lowest paying jobs of any sector of the economy. This lowers the annual average wages of workers in the study area. For example, Revere's internal economy generates income per job at only 74 percent of the state-wide average (City of Revere Growth Management Plan, 1987). A reliance on trade employment also lowers the average annual wage in the other communities. As shown in Table 15, only Lynn, because of its higher paying manufacturing jobs, exceeds the state's average annual wage.

The Boston region's economy has moved further away from a manufacturing based economy than any other urban area in the northeastern United States (American City Building, 1985). The region has evolved into an economic

**Table 15**  
**ANNUAL PAYROLL AND WAGES, 1986**

	<b>Total Annual Payroll (in thousands)</b>	<b>Average Annual Wage</b>
<b>Lynn</b>	<b>\$858,228.7</b>	<b>\$24,522</b>
<b>Saugus</b>	<b>\$151,092.0</b>	<b>\$15,536</b>
<b>Revere</b>	<b>\$129,122.1</b>	<b>\$16,282</b>
<b>Malden</b>	<b>\$369,214.9</b>	<b>\$18,459</b>

**SOURCE:** Massachusetts Division of Employment Security, 1987.

base dominated by services, finance, high technology, and research sectors that will continue to grow in the future. Overall, Boston's regional economy is dynamic and based on growing industries of the future.

Table 16 displays personal income and earnings for the Boston, New England County Metropolitan Area (NECMA). The manufacturing sector of the economy has a mixed forecast in the region. From 1969 to 1983, manufacturing of nondurable goods decreased from 10 percent to 6.2 percent, and is projected to decline to 4.8 percent by the year 2000 and further drop to 4 percent by 2035. However, manufacturing of durable goods earnings has increased from 1969 to 1983 (16 percent and 19 percent, respectively) and will continue to increase through the years 2000 (24 percent) and 2035 (27 percent).

Services earnings has also increased from 1969 to 1983 from 21 percent to 26 percent of total earnings. Services will continue to make up approximately 26 percent of the total earnings in 2000 and 2035. Finance, insurance, and real estate has increased from 1969 to 1983 and is projected to continue in to the next century.

When examining the contributions of manufacturing and services sectors to the economy by number of persons employed, a different picture emerges (see Table 18 in sub-Section d). The number of persons employed in all manufacturing made up 23 percent of employment in 1969. It dropped to 20 percent in 1983 and will continue at 20 percent in 2000 and is projected to increase to 21 percent by 2035.

Services shows a dramatic increase in the percentage of people employed. From 1969 to 1983, it rose from 23 percent to 29 percent. It is projected to climb to 31 percent by 2000 and remain at 31 percent in 2035. Therefore, though manufacturing of durable goods will continue to increase in earnings, the number of people employed in that sector will decrease. In services, the percentage of people employed is greater than the percentage of total

Table 16

PERSONAL INCOME AND EARNINGS,  
1969-2035

	1969	1983	1990	1995	2000	2005	2015	2035
Population as of July 1 (thousands) .....	3,682.0	3,673.4	3,936.0	4,141.3	4,301.3	4,443.5	4,698.2	4,990.0
Millions of 1972 Dollars								
Total personal income (place of residence)	17,800.3	24,586.3	30,846.6	34,869.8	38,358.6	41,643.7	47,916.0	60,336.7
By Place of Work								
Total Earnings	14,442.2	19,124.0	25,205.0	28,769.3	31,983.6	34,938.4	39,633.2	47,659.7
Farm	30.9	29.7	27.1	26.5	26.3	26.4	27.4	30.9
Nonfarm	14,411.3	19,094.3	25,177.9	28,742.8	31,957.4	34,912.0	39,605.9	47,628.7
Private	12,417.8	16,619.4	22,382.5	25,747.9	28,767.3	31,527.1	35,904.7	43,372.5
Agri. Serv. (Forestry, Fisheries & Other)			72.0	86.8	99.9	113.1	132.0	165.0
Mining		8.0	11.7	13.2	14.6	16.0	17.7	21.2
Construction	914.2	783.3	1,093.9	1,208.1	1,321.4	1,423.8	1,574.3	1,881.3
Manufacturing	3,025.5	4,901.1	7,050.9	8,158.3	9,243.3	10,355.3	12,107.0	15,309.9
Nonfarm	1,478.7	1,198.9	1,397.4	1,478.1	1,554.5	1,621.6	1,755.7	2,014.1
Durable Goods	2,346.8	3,702.2	5,653.4	6,680.2	7,688.8	8,733.8	10,431.3	13,295.8
Transportation and Public Utilities	898.5	1,258.1	1,721.3	1,992.8	2,252.4	2,494.0	2,857.9	3,462.8
Wholesale Trade	1,044.2	1,313.4	1,666.5	1,846.5	2,024.9	2,209.7	2,487.4	2,930.6
Retail Trade	1,577.8	1,693.1	2,017.2	2,244.7	2,453.6	2,622.5	2,870.5	3,414.8
Finance, Insurance, and Real Estate	1,035.6	2,028.7	2,337.6	2,596.7	2,810.9	3,010.9	3,128.2	3,655.3
Services	3,075.4	5,108.2	6,720.3	7,860.0	8,780.6	9,481.8	10,649.7	12,531.7
Government and Government Enterprises	1,993.6	2,474.9	2,795.5	2,994.9	3,190.0	3,384.9	3,701.1	4,256.3
Federal, Civilian	513.8	538.4	616.0	659.2	700.3	741.8	811.1	945.5
Federal, Military	116.7	149.1	165.0	173.6	182.3	191.3	212.0	258.8
State and Local	1,363.1	1,787.4	2,014.4	2,162.2	2,307.5	2,451.9	2,678.0	3,051.9

earnings. The reason is that though a greater number of people will be employed in the service sector, their earnings will be much lower than in manufacturing.

Trends in Boston's regional economy has been towards dispersal and suburbanization. While in 1975 total employment in greater Boston (Boston, Cambridge, Brookline, and Chelsea) comprised over 46 percent of the total SMSA employment, by 1982 it only comprised 42 percent. Of the 90,000 new jobs created throughout the SMSA between 1975 and 1982, 60 percent of these have been located in suburban communities outside of the greater Boston area (American City Building, 1985).

Though the Boston area has experienced significant regional growth, it has been slow to appear in the study area. While the total employment increased by 8.6 percent across the state from 1980 to 1985, it decreased by 9.3 percent in Revere and declined by 3.5 percent in Lynn (City of Revere Growth Management Plan, 1987 and Division of Employment Security, 1987). Only Saugus's employment has continued to grow (13 percent).

#### **(1) Commercial Fishing and Commercial Fishing Fleet**

Within the study area, lobster harvesting is the predominate commercial fishery. According to Jim Fair at the Division of Marine Fisheries, other commercial fisheries are insignificant in comparison. Little commercial fishing of any type occurs within the estuary itself. However, the estuary does play an important role for other commercial fisheries by providing spawning grounds for juveniles. Lobster is captured in Boston Harbor and beyond and landed at ports in Lynn, Saugus, and Revere/Chelsea. Together, the three areas landed 1,060,060 pounds of lobster in 1986, equal to 7.2 percent of all the lobster harvested in Massachusetts in 1986 (Division of Marine Fisheries, 1986). Saugus is the seventh highest ranking port in the state for pounds of lobster landed.

Recreational fishing is very popular in the estuary. Fisherman can be seen year round on bridges over the Saugus and Pines River and on the seaplane basin (City of Revere Open Space Plan, 1984). Shellfish resources are also significant in the estuary. But, due to the high fecal coliform count, the shellfish beds have been closed for many years. According to Brad Chase at the Division of Marine Fisheries, the shellfish resources could be of significant commercial value if the "water pollution problems associated with domestic sewage treatment are mitigated."

#### **d) Employment**

Since the study area municipalities are essentially residential suburbs to Boston, the majority of residents work outside the communities.

Employment within the communities is heavily concentrated in the services, wholesale, and retail trade sectors of the economy. These sectors of the economy have the lowest paying jobs. Services employment in the communities is characterized by personal services and very few higher paying professional services (City of Revere Growth Management, 1987). This correlation is explained in part by the communities role as residential suburbs. Another factor in Revere is the number of jobs in entertainment and resort related employment. Only Lynn has a substantial amount of people employed in manufacturing.

In 1986, the trade sector equaled 24.1 percent of the statewide employment while in Revere it equaled 44 percent of the jobs, and in Saugus 61 percent. Lynn and Malden were closer to the state figures.

The unemployment rate was higher in Revere, Lynn, and Malden in 1987 than it was across the state which was 3.2 percent (Table 17). The 1981 Boston PMSA (Primary Metropolitan Statistical Area) unemployment rate was 2.7 percent, further indicating that municipalities in the study area lag behind the Boston area in economic growth.

The change in the numbers of people employed within the study area municipalities differed from community to community. From 1980 to 1984 Malden and Saugus increased their employment by 1.4 percent and 7.2 percent respectively. This is lower than the Metropolitan Area Planning Council (MAPC) region which increased by 8.6 percent. Lynn and Revere experienced an even more severe difference from the MAPC region. Revere's employment

dropped by 12.6 percent and Lynn's by 4.2 percent. However, Revere appears to have reversed the downward trend having gained 764 jobs in 1986. Lynn, however, has continued to lose jobs.

The forecast for jobs within the communities is difficult to determine. The Massachusetts Division of Employment Security does not make predictions for future employment. Employment trends can be projected, however, for the Boston area. Table 18 shows employment projections by industry. Employment is projected to increase in all sectors of the economy except in manufacturing nondurable goods and government enterprises.

**Table 17**

**ANNUAL AVERAGE EMPLOYMENT, 1987**

	REVERE	SAUGUS	LYNN	MALDEN
Labor Force	22,634	14,382	39,364	28,590
Number Employed	21,796	14,022	37,952	27,614
Number Unemployed	838	360	1,412	976
Unemployment Rate	3.7%	2.5%	3.6%	3.4%

Table 18  
BOSTON NECHA  
EMPLOYMENT BY PLACE OF WORK AND BY INDUSTRY  
1969-1983 AND PROJECTED, 1990-2015

	1969	1983	1990	1995	2000	2005	2015
Total Employment	1,726.1	2,064.9	2,439.1	2,638.7	2,784.7	2,884.3	2,952.0
Farm	6.3	5.4	5.2	5.0	4.9	4.8	4.6
Nonfarm	1,719.8	2,059.6	2,434.0	2,633.7	2,779.8	2,879.5	2,947.4
Private	1,407.3	1,781.2	2,150.2	2,346.2	2,489.9	2,588.0	2,660.4
Agri. Servs. forestry, fisheries, other			13.8	16.2	18.0	19.5	20.9
Mining		.8	1.0	1.1	1.2	1.2	1.3
Construction	84.2	74.6	96.2	102.1	107.4	111.4	113.9
Manufacturing	403.5	410.6	509.0	546.6	578.0	605.3	628.3
Nonurable Goods	178.2	121.8	125.1	123.8	122.1	119.5	114.7
Durable Goods	225.3	288.8	383.8	422.9	455.9	485.8	513.7
Transportation and Public Utilities	87.2	92.0	107.8	116.5	124.1	130.2	134.2
Wholesale Trade	98.9	115.2	131.4	139.2	146.3	153.1	158.5
Retail Trade	283.2	330.6	381.6	412.7	435.2	449.6	458.3
Finance, Insurance, and Real Estate	104.4	104.4	172.8	191.0	204.4	213.5	220.2
Services	401.8	605.3	736.7	820.7	875.2	904.1	924.9
Government and Government Enterprises	249.5	278.3	283.8	287.5	289.9	291.6	287.0
Federal, Civilian	52.7	45.0	45.8	46.2	46.4	46.6	45.8
Federal, Military	35.6	30.5	30.5	30.5	30.5	30.5	30.5
State and Local	161.2	202.8	207.4	210.7	213.0	214.5	210.7

Source: 1985 OBEERS

**e) Population and Community Growth, Including Displacement**

All the communities have experienced a drop in population from 1980 to 1988 as shown in Table 19. Revere and Malden have experienced significant drops in population. The study area, however has been projected to increase in population by 5.1 percent from 1980 to 1988 (CACI, 1988). By 1990, the population in Saugus and Revere is projected by MAPC to increase. Precise population projections are difficult to make. Different parameters were used to make the CACI and MAPC population projections. It appears that the population decrease will slow in Revere and Lynn. New residential developments in Revere will increase the population in the community and the study area.

Though total population is decreasing in the communities, the total number of households is increasing. This follows the national trend for increased number of households and smaller average sized households. Households have increased due to higher incident of divorce, young adults staying single longer, and the increased longevity and independence of the elderly.

Another population factor shaping the community is the age composition of the population. The median age in the communities is 33.9 years (34.3 in the study area) versus 31.3 years for the Boston SMSA in 1980. In 1980, age 65 and over equaled 15.8 percent in the study area compared to 12.5 percent in Boston SMSA and an average of 14.6 in communities. These factors shape the type of housing, services and economic growth that will occur in the study area.

Displacement will occur within the study area if the demand for housing continues. As housing prices continue to rise, long-term residents will be excluded from the housing market.

Table 19

## POPULATION: COMMUNITIES AND STUDY AREA

Town	1960	1970	1980	1988	Percent Change 1980-1988	MAPC Forecast 1990	CACI Forecast 1993
Lynn	94,478	90,294	78,471	78,463	- .01%	78,000	—
Saugus	20,666	25,110	24,746	24,628	- .50%	24,700	—
Revere	40,080	43,159	42,423	39,512	-6.9%	42,400	—
Malden	57,676	56,127	53,386	51,904	-2.8%	50,300	—
Study Area	—	—	19,803	20,806	5.1%	—	21,034

Sources: U.S. Census of Population, 1960, 1970, 1980.

Town and City Clerk's Offices

MAPC Community Profiles, 1986.

CACI, 1988.

## POPULATION: BOSTON NEOMA

	1969	1973	1978	1978	1983	Percent Change 1978-1983	1990
Boston NEOMA	3,682.8	3,749.3	3,677.6	3,673.4	3,673.4	-.1%	3,936.8

(in thousands)

Source: Obers, 1985.

# **f) Public Facilities and Services and Tax Revenues**

Public facilities include all public buildings (e.g., schools, town offices, libraries, police and fire stations), road systems, water control facilities, public utilities (e.g., sewer, electric, gas and water lines). In addition to debris clearance and protective measures (e.g., seawalls, dikes, and levees) as emergency categories, public facilities are eligible for federal funding following a disaster. A means of assessing the impact to public facilities and services from flooding is to look at historical records of disaster assistance. Using funding amounts from the 1978 Blizzard, the communities of Lynn and Revere were reimbursed a total of \$396,866 for public losses (Table 20). Revere accounted for 96 percent of the funding with 4 percent going to Lynn, Saugus received no federal reimbursement.

<b>Table 20</b> <b>FEMA FUNDING TO MUNICIPALITIES AFTER</b> <b>THE BLIZZARD OF 1978*</b>			
	Lynn	Saugus	Revere
Debris Clearance	\$0	\$0	\$ 36,721
Protective Measures	\$0	\$0	\$107,189
Road Systems	\$ 480	\$0	\$ 89,703
Water Control Facilities	\$13,945	\$0	\$ 2,419
Public Buildings	\$0	\$0	\$ 800
Public Utilities	\$0	\$0	\$124,605
Other	\$ 1,163	\$	\$ 19,841
<b>TOTAL</b>	<b>\$15,588</b>	<b>None Listed</b>	<b>\$381,278</b>
<b>* CORPS, 1979. <u>Blizzard of '78 Coastal Storm Damage Study</u></b>			

Comparing the total (private and public) damages from the Blizzard for Revere (\$16 million) and Lynn (\$10 million) with the public damage figures, approximately 2 percent of the costs went to the repair of public facilities.

## **g) Transportation**

The region is characterized by dense residential populations with numerous local roads burdened with through traffic going to and from Boston. The marsh has played an important role in transportation planning. In early years it was a barrier to road building. It became an opportunity in the middle of this century by providing wide open land for road building that needed only fill (building through existing development requires expensive acquisitions and costly, time consuming infrastructure modifications). The marsh is now a protected resource in which vast filling is contrary to law and proper ecological planning.

### **1) Streets and Highways**

Route 1A is a primary north-south artery running through Revere along the barrier beach over the mouth of the Saugus River via the General Edwards Bridge and through Lynn. It is known as the North Shore Road and as the "Lynnway" near the river. Route 1A also services the beach area, Wonderland Dog Track, the MBTA Blue Line Station, and adjoining parking areas. This route has little access control (except towards the southern approach to the bridge) and is characterized by heavy stop and go congestion. At the time of this study, repairs to the bridge worsened congestion conditions. The route had an average daily trip count in 1987 of 15,500 in the study area (Vannasse/Hangen, 1987). The southbound side experiences the longest delays in the morning peak hour and the northbound in the evening peak hour.

Route 107 runs directly through the middle of the Saugus marsh. It is a four lane highway connecting East Saugus with central Revere. Traffic moves rapidly across the marsh, but congests quickly on either side. Route 107 is approximately ten feet above sea level. This route was flooded during the 1978 blizzard and the January 1987 storm (Source: MAPC).

The Revere Beach Connector was proposed (as far back as the 1950's) to be a four-lane divided, east-west highway connecting Cutler Circle to Route 1A, constructed in the marsh. This was to relieve the considerable traffic through local Revere streets that was headed for the beach in summer and the race tracks. A large area of fill was deposited just north of Route 107 to observe settling characteristics in anticipation of the Connector's construction. A draft Environmental Impact Statement was issued in 1979, but work on the project was halted by the Massachusetts Department of Public Works. Concern over environmental impacts raised by the Federal Highway Administration, the U.S. EPA, the Army Corps of Engineers, Coastal Zone Management, the Coast Guard, and Department of the Interior essentially terminated the project.

Interstate 95 was to have run across the marsh from the Northgate Shopping district through East Saugus. Its failure is the most significant aspect of the region's transportation network. Ironically, it was not the marsh that precluded its construction, but the interests of Saugus on the northern upland side.

## 2) Rail Systems

Revere (Wonderland) is the northern terminus of the MBTA's Blue Line, a commuter rail system. The Blue Line accesses downtown Boston via Logan Airport. Donald Kistin, of the MBTA planning division, discussed the potential for extending the Blue Line north (parallel to the existing Boston & Maine track) to service the North Shore. The plans were halted due to reduction in transportation funding by the federal government. Presently there is no predicting whether this plan will go forward in the near future.

Construction would require widening the existing rail bed and building another bridge across the Saugus River.

The Boston and Maine Railroad is a commuter rail service servicing the North Shore and beyond. According to Mr. Kistin, plans are underway to construct a station in East Saugus.

#### **h) Summary of Social and Economic Factors**

- The study area communities of Lynn, Saugus, Malden, and Revere are densely populated areas within the greater Boston metropolitan district.
- Historically, salt marsh within the Saugus and Pines Rivers estuary has been filled in the communities of Lynn to support industrial growth primarily, Saugus to support residential growth, and Revere, to support residential and commercial growth.
- Known for development within the study area (approximate Standard Project Northeast) include several new mixed-use proposals in Lynn, commuter rail station in Saugus, and numerous condominium projects in Revere.
- Strong environmental laws and regulations at the federal, state, and local levels have been in effect since the latter 1970's essentially prohibit development within marsh environments.
- Without a federal flood control project, the regulated flood plain is proposed to increase throughout the study area.
- Housing values have risen in water-front areas, however, the desirability of building and living in the flood plain remains an issue, primarily in East Saugus and Revere.

- Although the Boston area has experienced significant regional growth, much of it has bypassed the study area.
- Population is decreasing in the communities but the total number of households is increasing.

## **VI. B. 12. Navigation**

## **VI. B. 13. Recreation and Open Space**

### **13. Recreation and Open Space**

#### **Lynn**

There are seven recreational opportunities within the City of Lynn study area. Included in this area are the following: two neighborhood playgrounds, two community playfields, one community park, one boat launching area and one public beach area. These recreation sites are classified according to their geographic range of service area and recreational activity. Neighborhood playgrounds are estimated to serve participants within approximately one-quarter mile of the site while community playfields serve participants from a one-half mile radius to the city-wide population. The public boat launching area, community park and public beach area are estimated to serve the city-wide population (City of Lynn Open Space Plan, 1985).

Recreational facilities and open space areas are seen as serving a special need in improving and upgrading Lynn. Renovation of recreational facilities are tied to the long term objective of community development. Included in Lynn's neighborhood revitalization strategy is a provision to upgrade the local parks and improve open spaces since this is seen as a method to help stabilize real property values. It is also believed that these actions will encourage economic growth in the community.

Part of these improvement plans include increasing pedestrian access to water resources, both to the coast and the river. Currently, access to these sites is limited due to the Lynnway creating a physical and psychological barrier to the oceanfront, and the industrial uses along the Saugus River blocking the river front. The unattractiveness of the sites and their distance from residential areas contributes to their underutilization.

The deteriorated condition of the areas bordering the coast and river can have negative impacts to planned recreational opportunities and water related recreation sites.

Lynn is planning on upgrading existing facilities and sees a need for increasing recreational facilities as the population and number of households grow. Increasing pedestrian links to recreational facilities is needed to increase the use of these resources.

### **Revere**

Recreational activities in Revere are dominated by Revere Beach. Since 1896, the beach has been owned and managed by the Metropolitan District Commission (MDC). In 1979, the MDC acquired an additional 13 acres of land adjacent to the beach. Historically, Revere has lacked any local public investment in parks and recreation because private entrepreneurs and the MDC readily provided them. Revere even lacks a public common, unlike the majority of New England towns, because Chelsea has served as the commercial center for the region.

In most categories, Revere is deficient in recreational facilities according to recreational standards. Within the study area, there are eight Neighborhood Parks, three City Wide Parks and two Regional Parks (Revere Beach is included in this list) (City of Revere Open Space Plan, 1984).

Most residents use recreational facilities outside of the city. There are problems with the run-down condition of most of the facilities due to poor maintenance, poor quality equipment, and insufficient amounts of equipment. In a survey conducted by the City, well over 50 percent of Revere's households did not use any of the city parks and playgrounds (City of Revere Open Space Plan, 1984).

Revere has seven marinas, of which six are privately owned. The following is a list of these water based recreation facilities (City of Revere Open Space Plan, 1984):

Point of Pines Yacht Club  
Captain Fowler's Marina  
Broad Sound Tuna Club  
General Edwards Yacht Club  
North Shore Boat Works

Boating is so popular in the area that plans have been made to expand the marinas. Neighborhood opposition, however, has been high against these proposals because of problems with increased traffic and parking.

Sport fishing for winter flounder, mackerel, striped bass, smelt and codfish are popular at all times of year along the bridges over the Pines and Saugus River, Seaplane basin and Point of Pines.

There are no designated nature walks in Revere. People on their own may stroll through the marsh and the I-95 embankment forms a walkway through the marsh. From windshield surveys, it appears that the embankment is also used for dirtbike trails.

Only one of the recreational facilities in the study area is adjacent to the marsh. Jacobs Park, along Hastings Street, is a five-acre proposed park site. Presently, this site is nothing more than a cleared area at the edge of the marsh.

The MDC is currently upgrading Revere Beach. Plans include new plantings, upgrading park structures, such as the historic pavilions, and improving transportation corridors and pedestrian access to the beach. Revere also has plans to upgrade their recreation facilities.

**Saugus**

Within the study area in Saugus, there are few recreational facilities. There are three playgrounds and one neighborhood park. One playground is four acres and contains a softball field, play equipment, and a basketball court. The Ballard School has a half-acre playground with some recreational equipment. Along the Saugus River, there is a 6.4-acre playground with a little league field. Due to its location and lack of visibility, it is in extremely poor condition and subject to extreme vandalism.

Lobstermen's landing/marine Mini Park is a neighborhood park and boating facility along the Saugus River. One parcel is 14 acres of marsh. Another is one-half acre of river front. The third parcel is approximately 40 acres of a marsh area which the Town acquired via tax title action.

Saugus is currently updating its open space and recreation plan.

**VI. B. 14. Noise**

#### **14. Noise**

Ambient noise is a very site specific occurrence, and cannot be generalized for a broad area. Ambient noise levels within the study area are difficult to determine since ambient noise levels are not routinely measured. Noise levels are only measured by local and state government agencies if they are related to complaints.

Calls to the Department of Environmental Quality Engineering failed to uncover any records of measurements of noise levels at the site of the proposed floodgate. It was suggested that the only way to determine current noise levels would be to take measurements.

**VI. B. 15. Air Quality**

## 15. Air Quality

The Commonwealth of Massachusetts is divided into six Air Pollution Control Districts. The study area is located within the Metropolitan Boston Control District. The Federal Clean Air Act protects the quality of the air by setting National Ambient Air Quality Standards (NAAQS) for specific criteria pollutants. Six criteria pollutants (carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, lead, total suspended particulates and particulate matter less than 10 micrometers in aerodynamic diameter [PM10]) were measured with both private and public stations equipped with air pollution monitoring equipment in 1986. One private site is located in Lynn at 423 Lynnway Street and measured only sulfur dioxide.

Table 21 displays the highest recorded levels for the pollutant criteria in Metropolitan Boston. There were few exceedances of the NAAQS Standards. Within the Metropolitan Area, the carbon monoxide standard was exceeded twice during 1986. The third exceedance was in Chelsea for ozone during two measuring periods.

A Pollutant Standard Index is a measurement of the ozone in the atmosphere and grades days according to the general health effects of the air. Ozone is only measured from April to October in metropolitan Boston since it is predominately a photochemical reaction from other pollutants. Ratings range from good, moderate, unhealthy, very unhealthy, and hazardous. Within the Eastern region, during the 214 day ozone season, 120 days were rated good, 86 moderate, and 8 unhealthy. No days were rated above the unhealthy level.

Table 21

## 1986 AIR QUALITY

<u>POLLUTANT</u>	<u>AVERAGING INTERVAL</u>	<u>NAAQS PRIMARY STANDARDS</u>	<u>NAAQS SECONDARY STANDARDS</u>	<u>HIGHEST METRO. BOSTON READING</u>	<u>LYNN STATION</u>
Sulfur Dioxide (SO <sub>2</sub> )	Annual 24 Hour 3 Hour	80 ug/m <sup>3</sup> 365 ug/m <sup>3</sup> —	— — 1,300 ug/m <sup>3</sup>	42 ug/m <sup>3</sup> 147 ug/m <sup>3</sup> 377 ug/m <sup>3</sup>	31 246 456
Total Suspended Particulates (TSP)	Annual 24 Hour	75 ug/m <sup>3</sup> 260 ug/m <sup>3</sup>	60 ug/m <sup>3</sup> 150 ug/m <sup>3</sup>	82 ug/m <sup>3</sup> 220 ug/m <sup>3</sup>	— —
Carbon Monoxide (CO)	8 Hour 1 Hour	10 mg/m <sup>3</sup> 40 mg/m <sup>3</sup>	10 mg/m <sup>3</sup> 40 mg/m <sup>3</sup>	12 mg/m <sup>3</sup> 25 mg/m <sup>3</sup>	— —
Ozone (O <sub>3</sub> )	1 Hour	.12 ppm	.12 ppm	.125 ppm	—
Nitrogen Dioxide (NO <sub>2</sub> )	Annual	100 ug/m <sup>3</sup>	100 ug/m <sup>3</sup>	64 ug/m <sup>3</sup>	—
Lead (Pb)	3 Month	1.5 ug/m <sup>3</sup>	1.5 ug/m <sup>3</sup>	.19 ug/m <sup>3</sup>	—
PM 10	Annual 24 Hour	50 ug/m <sup>3</sup> 150 ug/m <sup>3</sup>	50 ug/m <sup>3</sup> 150 ug/m <sup>3</sup>	41 ug/m <sup>3</sup> 122 ug/m <sup>3</sup>	— —

Source: 1986 Air Quality Report, Division of Air Quality Control, DEQE


 IEP  
inc.

Predicting the future of air quality within the study area is difficult since pollution sources come from both distant sources (New York, Ohio) and Metropolitan Boston sources. However, if significant economic growth and housing occurs in the area, then some increased air pollution can be expected. Increased traffic and fossil fuel emissions would increase the level of all of the criteria pollutants.

**VII. A. 11. Social and Economic Factors**

## **VII. Environmental Effects of Detailed Plans Including Construction, Operational and Maintenance Phase Effects**

### **A. Plan Impacts**

#### **11. Social and Economic Factors**

##### **Introduction**

The following sections describe the impacts on the study area if one of three options for flood damage reduction is undertaken. The Corps of Engineers has investigated three alternative strategies for flood damage reduction. They are:

**OPTION 1:** This includes 8.6 miles of new walls and dikes (generally 4 to 7 feet high) mostly bordering on developed properties near wetlands, and a park dike between Revere Beach Boulevard and Ocean Avenue, as well as walls and dikes along Lynn Harbor (see Table 22 for details of construction activities for Option 1).

**OPTION 2:** This program involves floodproofing of existing structures within the study area. Floodproofing, for example, might entail the raising of a building above the flood plain. Preliminary analysis by the Corps indicates about eight percent (265) of the buildings inside the SPN and 10 percent inside the 100-year floodplain, are candidates for feasible floodproofing. Flood warning and evacuation plans would be implemented for the entire SPN floodplain.

Table 22

## OPTION 1 - CONSTRUCTION: FEATURES, DURATION, TRUCKING, LABOR

## LOCAL PROTECTION PLANS: 500-YEAR LEVEL OF PROTECTION

MAJOR FEATURES	LYNN	REVERE BEACH BACKSHORE	EAST SLUICES	TOWN LINE BROOK	TOTAL OPTION 1
	<u>Lynn Harbor:</u> ● 8,380 LF of Dikes & Walls  <u>Saugus River:</u> 11,625 LF-Walls  <u>Also:</u> 13 Closures and 42 Sluice Gates	<u>Park Diike:</u> ● 3,420' Diike/Walls ● Revere Beach, North ● Raise 1,800 LF of Wall 2 ft & 300 ft Revetment ● Pond & Wall 900 LF Pines River: ● 10,180 LF Walls <u>Also:</u> 7 Closures & 4 Sluice Gates	● 8,000 LF of Walls & 14 Closures & 2 Sluice Gates	● 1,250 LF of Diike and Wall & 1 Closure & 6 Sluice Gates	45,555 LF (8.6 Miles) 35 Closures & 54 Sluice Gates
Construction Duration (Months)	18	18	9	4	24
Total Truck Trips Required	9,500	10,700	840	140	21,180
Average Truck Trips per Day	21	24	4	2	50
Workers/Day (Average)	31	33	25	7	100

OPTION 3: Includes 3.2 miles of new structures, including: a floodgate at the mouth of the Saugus River, a park dike between Revere Beach Boulevard and Ocean Avenue, walls and a dike along Lynn Harbor, and revetments, dunes, walls and beach at Point of Pines (see Table 23 for details of construction activities for Options 3).

Options 1 and 3 are designed to reduce flood stages, in other words, they will keep flood waters back from the built environments. Option 2 will reduce flood damage, but not flood stages. Flood waters would still enter the study area if Option 2 were implemented.

For the purposes of this report, the order of presentation for each alternative shall be Option 1, Option 3, and Option 2. The socioeconomic impacts to the area are very similar for Options 1 and Option 3. This is because they are both designed for the same degree of flood stage reduction. Thus, rather than repeat the material described for Option 1 in each section for Option 3, it should be assumed the impacts for Option 1 are the same unless specifically differentiated. Most of the significant differences between Option 3 and Option 1 are related to the construction impacts.

The floodproofing of buildings (Option 2) will have little overall socioeconomic impact on the study area. There would be some increase of property values surrounding the improved structures. It would do nothing to change development patterns in the area. The construction impacts would be site-specific and of short duration (six months to a year to renovate a structure). However, they would entail a significant localized impact. Traffic would be disrupted within neighborhoods and noise levels would be increased, as with any construction project.

Table 23

## OPTION 3 - REGIONAL FLOODGATE PLAN

CONSTRUCTION: DURATION, TRUCKING, LABOR

	SNIGUS RIVER FLOODGATE			CONCURRENT WORK		
	PHASE 1 Navigation Gate Lynn Gates 1-4	PHASE 2 Lynn Gates 5-9 & Rev. Gate	PHASE 3 Revere Dike	REVERE Park Dike	LYNN Harbor Walls/ Dikes	Point of Pines
Construction Duration (Months)	12	10	4	9	12	12
Total Truck Trips Required	920	650	610	4,055	6,925	3,910
Average Truck Trips Per Day	4	3	10	21	27	15
Workers/Day on Site (average)	56	50	12	17	18	15

Source: Army Corps of Engineers

The Floodgate scheme includes a Miter navigation gate;  
 9-15' x 50' Taintergates, Lynn side; 1-15' x 50' Taintergate, Revere side;  
 constructed with Ring and Braced cofferdams.

**a) Land Use, Direct and Induced Effects**

**OPTION 1 and OPTION 3 (Floodgate)**

What would be the potential for induced development given the construction of the Saugus River flood stage reduction measures? There is a general perception among many of the correspondents with the Corps of Engineers that the project will considerably increase the potential for land development within the study area.

In order to assess this potential, the study area has been separated into three environments namely, 1) the wetland resources, primarily salt marsh, 2) land between the salt marsh and the upland limit of the FEMA A-Zone or 100-year flood plain, and 3) between the 100-year flood plain and the Standard Project Northeaster (SPN) limit.

There are two primary factors which presently inhibit development within the project area. The Wetland Protection Act places severe limitations on any activity within the wetland resources environment, in this case salt marsh. The (FEMA) regulations (as administered through local flood plain zoning bylaws and the State Building Code requirements for building in flood hazard areas) increase construction requirements, and hence, costs to buildings built within the floodplain. There are no regulations relevant specifically to the area between the FEMA 100-year flood zone and the SPN.

**Construction in the Wetland Environment**

The most consistent concern raised in the project correspondence to the Corps regarded the increased potential for development in the wetland environment. Several letters expressed the attitude that with the potential for flooding removed, developers would undertake more projects in the marsh. The Massachusetts Association of Conservation Commissions (MACC) newsletter

for September of 1987 stated in part, "...environmentalists fear that prevention of flooding may cause ecological damage. The floodgates may also permit developers to build in the marshes, which so far have been protected from development to some extent by the danger of flooding." Were flooding the only constraint, this may be true.

Regulations under the Wetlands Protection Act (MGL ch. 131 s. 40) state, "When a salt marsh is determined to be significant to the protection of marine fisheries, the prevention of pollution, storm damage prevention or ground water supply, the following regulations shall apply: (3) A proposed project in a salt marsh, on lands within 100 feet of a salt marsh, or in a body of water adjacent to a salt marsh shall not destroy any portion of the salt marsh and shall not have an adverse effect on the productivity of the salt marsh. Alterations in growth, distribution and composition of salt marsh vegetation shall be considered in evaluating adverse effects on productivity" (310 CMR 10.32).

The marsh presently serves as an important spawning ground for numerous fish and shellfish resources. According to Vernon Lang, Fish and Wildlife Service of the U.S. Department of the Interior, "The importance of the Saugus and Pines River estuary cannot be overemphasized since it contains a wide variety of public trust resources. Nearly 70 percent of all commercial fish and shellfish resources are dependent upon estuaries for spawning and nursery grounds. This estuary with its salt marshes, mudflats, and shallow subtidal channels is one of the most biologically significant estuaries in Massachusetts north of Boston. Marine worms, snails, and other shellfish in the marsh form the basis of the macromarine food chain. Winter flounder, alewife, smelt, blueback herring, and eels are a few of the more common recreationally valuable finfish that occur in the Saugus and Pines River Estuary. Spawning and nursery habitat is available in the estuary for many of these species. Additionally, Atlantic silversides, mummichogs, and

sticklebacks occur in the pannes of water in the marsh." These statements are reiterated by Thomas Bigford of the National Marine Fisheries Service (Army Corps Correspondence No. C-13).

In order to fill portions of the salt marsh, a developer would need to overcome the presumption that the interests discussed above were not being protected by this marsh. This could not be done (see discussion in Section VI.B.11.a.2.d.i.).

#### **Conservation Commissions have jurisdiction over the marsh.**

The municipal authorities having jurisdiction over activities in and near the marsh are the Conservation Commissions. Any project which would alter land in or within 100 feet of a wetland resource must come before the Commission. While the Commission has considerable discretionary powers over projects within 100 feet of a resource area, known as the "buffer zone," there is very little that is allowable under the regulations within the resource itself. Construction activities are limited to elevated walkways and piers. Thus, it is concluded, a flood reduction project could not induce construction within the marsh.

#### **Construction in the Flood Plain**

Between the FEMA 100-year flood plain and the SPN flood elevation, there are no relevant regulatory impediments to construction. The only constraints would be the result of perceived flooding threats. Recorded history has never seen a SPN storm event in this area (conditions for a 160-year storm event were experienced in 1909). It is doubtful many people living in or contemplating construction in the area would be cognizant of the SPN flood plain. If they were, they would be considering the odds of a flood whose probable occurrence was one percent or less each year. This factor would be of a very minor priority were this to be incorporated into a business

decision to develop an area. Most importantly, there is very little remaining developable land within the region between the SPN and 100-year flood plains (see Section VI.B.11.a.2.a.).

The area within the 100-year flood plain is determined by the 100-year storm event (one that has a one-percent chance of being equaled or exceeded once on the average during any 100-year period the recurrence interval). These are based on historical evidence and mathematical models. The storm event which provides the best reference point for residents of the area was the northeaster which occurred on February 6 through 7, 1978. This was given an approximate recurrence interval of 90 years (Flood Insurance Study, City of Revere, FEMA 4/16/84). The Corps of Engineers put the return frequency at closer to 100 years ('78 Blizzard Study, 1979). Thus, for ease of understanding, a 100-year tidal storm event is similar to the 1978 blizzard.

The study area within the flood plain is presently highly developed (see Section VI.B.11.a). Relative to its size, there are a small number of vacant building sites within the study area (284 residential, 180 commercial and industrial; Tables 9, 10, and 11).

All of the study area inside of the General Edwards Bridge is classified as A Zones (or acceleration zones) by FEMA. These are contrasted with V Zones, or velocity zones. Velocity zones are essentially those areas exposed to relatively open ocean. They will experience considerable impact from breaking waves. Acceleration zones are areas of rising and moving waters without significant wave action. Velocity zones have much more stringent building restrictions. The study area is located within a barrier beach system and therefore, relatively protected from open ocean activity with the exception of those areas behind Revere Beach and Lynn Harbor. All areas which may experience increased development pressures are in A zones.

Unlike the salt marsh areas, building is not prohibited in the flood plain. There are, however, several requirements for construction in the flood plain which can be generalized as follows:

- o The lowest habitable floor of a building must be raised above the 100-year flood elevation.
- o No mechanical equipment (heating, etc.) may be located below the 100-year flood elevation.

Presently, the highest FEMA flood in the study area is 11.4 feet (Revere's Zone 2A). Most of the upland area is several feet above mean sea level (0.0 feet NGVD). Thus, most often it is the case that a building need only be raised a few feet to meet the requirements. Examples of actual costs are set forth in Section VI.B.11.a.2.d.iii.

It is the additional cost of building above the flood plain plus the present value of the flood insurance premiums that impacts construction. Often, much of the additional costs of construction can be recouped in added value to the building. For example, a commercial building under construction during this study near Point of Pines will utilize the space under the elevated structure for parking. Such a situation may actually result in little additional cost to the developer due to savings on other land for parking.

Numerous conversations with developers, realtors, and local officials all indicate that fear of flood damage has not hampered building activity. Some people may have avoided the areas for their commercial or residential projects, but the market has supplied others to take their place.

The most common statement by developers contacted is that if the economic situation justifies the additional expense, they will build (elevated)

structures in the flood plain. Simply stated, the regulations control building but do not prevent it. Other economic factors are more important than the elimination of these regulations within a part of the study area.

### **FEMA and Corps Base Flood Elevations Differ**

One further area that requires discussion is the basis of the 100-year flood plain used by FEMA and that used by the Corps in this study. As discussed earlier (VI.B.11.(d)ii.), the FEMA base flood elevation is presently lower than that indicated by Corps of Engineers' information. FEMA has confirmed that if the flood reduction project is not constructed, it will likely raise their base flood elevations to match the better analysis (Table 8). If the project is constructed, they will likely lower their base flood elevations (Table 24). The point to understand, however, is that the larger area of the Corps of Engineers designated flood plain included in this study is not presently regulated by FEMA. For example, in much of the study area, only approximately two-thirds of the area inundated by the 1978 blizzard is within the FEMA flood plain. Therefore, any reduction in regulated flood plain brought about with the project, in a practical sense, can best be measured from the current FEMA regulated area. The insignificant effect of the project on development within the flood plain is the same, however, regardless of whether the FEMA or Corps flood plain boundary is used.

In conclusion, the Wetland Protection Act presently prevents development in the marsh and would continue to do so if either of the flood stage reduction projects (Options 1 and 3) were constructed. In the flood plain, regulations control building but do not prevent it. Other economic factors are more important towards inducing development than eliminating these regulations. As a result, the impact of the project on flood plain development is relatively insignificant.

**Table 24**
**MODIFICATION OF 100-YEAR FLOOD ELEVATIONS  
WITH THE FLOOD REDUCTION (OPTION 3) PROJECT**
**LYNN**

<u>Flood Zone</u>	<u>CORPS (With Floodgate)</u>	<u>FEMA (1984)</u>
1 - Lynn, Harbor Coastal Area	8.4	12.0/11.0
2 - Lynn General Electric Area	8.4	9.0
3 - Lynn, Saugus and Little Rivers Area	7.3	8.0
4 - Lynn, Saugus, River - B & M Tracks to Boston and Summer Street	7.3	8.0

**EAST SAUGUS**

<u>Flood Zone</u>	<u>CORPS (With Floodgate)</u>	<u>FEMA (1982)</u>
1 - Saugus River to Ballard Street	7.3	10.0
2 - Between Ballard and Bristow Street	6.0	10.0
3 - Saugus Marsh to Bristow Street	7.3	10.0

**NORTH GATE**

<u>Flood Zone</u>	<u>CORPS (With Floodgate)</u>	<u>FEMA (1984)</u>
Zone 1 and 2	7.3	9.0

**REVERE**

<u>Flood Zone</u>	<u>CORPS (With Floodgate)</u>	<u>FEMA (1984)</u>
3A-C - Towle, High School, Broadway	6.0	6.0
4A - Kelley's Meadow	4.6	8.0
4B - B & M Railroad	3.6	7.0/9.0
4C - Revere House	5.4	8.0
5B - Revere Beach Blvd to Rt. 1A	7.3	9.0
5A, C, D - Riverside and Pines River	7.3	9.0

**OPTION 2 (Floodproofing Existing Structures)**

As this will affect less than eight percent of the buildings in the study area and only concern existing buildings, it would have no significant impact to land use in the area.

**b) Property Values and Housing****OPTION 1 AND OPTION 3**

It can be generalized that market values of properties inland of the General Edwards Bridge would rise for the following reasons:

- Assuming the FEMA base flood elevation will be lowered, cost of construction and reconstruction within the study area will be reduced (see sub-section 11.a.2.a, above).
- Lowering FEMA levels will eliminate flood insurance premiums for properties presently within the FEMA base flood elevation.
- Improvement of existing structures is curtailed by FEMA-driven building regulations. Eliminating the need to bring a building up to present floodproofing requirements will make economically feasible many upgrading projects that before were too costly. This "redevelopment" will tend to push up values of surrounding properties.
- Elimination of the threat of a large flood such as the 1978 blizzard will have some impact on property values. Numerous discussions with Realtors and property owners revealed a vague fear of future floods. One respondent said that it made him think twice about putting money into fixing up his house.

**OPTION 2**

The floodproofing of existing buildings will obviously increase their value. However, the general increase in property values area-wide is too insignificant to quantify as it will effect about 8 percent of the existing structures.

**c) Business, Industrial, and Fishing Activity****OPTION 1 AND OPTION 3**

Master plans for all communities within the study area have urged redevelopment and upgrading of the built environment. See section VI.B.11.c., above. Little information is available that considers development potential should flooding be reduced. For example, in a study prepared to assess the development potential of Lynn's South Harbor, noticeably absent was any discussion of constraints presently posed by flooding potential. This is typical of most development analyses.

The commercial lobster and fishing industry would benefit considerably from the floodgate. By necessity, all their operations are situated in high-hazard proximity to the water. Agents contacted for the industry say no plans are in the works contingent upon the flood reduction project.

**OPTION 2**

No significant impact is anticipated.

**d) Employment****OPTION 1**

This project will generate a number of construction jobs. See Table 22 for a breakout of the number of workers on a per day basis for the various projects of this plan. On average, the project will require 100 workers per day during the two to three year course of this project. Beyond the construction phase of this project, there will be sporadic maintenance work created.

**OPTION 3**

As with Option 1, the project will generate primarily construction jobs. The direct cost of the floodgate, Revere Beach features and Lynn Harbor features is projected to be about 60,000,000. Assuming labor costs at about 15 percent with an average labor cost per man hour of \$30, an estimate of about 200 man years of employment would be made available by the project. Over the life of the project, an average of 70 workers per day would be employed (see Table 23).

After completion, it is estimated that the average annual operation and maintenance cost will run \$400,000 per year. Maintenance employment would be sporadic.

Exclusive of the actual project, employment in the study area may be increased by additional construction. However, as detailed earlier, this impact will be more a factor of the general economic conditions as opposed to being directly influenced by the project.

**OPTION 2**

Floodproofing of structures will create site-specific construction and engineering employment. It will have no long-term impact on overall employment in the study area.

**e) Population and Community Growth, Including Displacement****OPTION 1 AND OPTION 3**

No information is available to quantify the change in population or community growth should the flood stage reduction project proceed (see Section VI.B.11.e) Option 3 would involve no displacement of residents because of the location of the various components of the project and small area requirements.

If FEMA flood-proofing requirements are lifted (see Section VII.A.11.a) renovation activity to existing buildings will increase. Revitalization, more so than new construction, is impeded by flood plain building requirements.

**OPTION 2**

Floodproofing of existing buildings will have no impact on population and community growth.

**f) Public Facilities and Services and Tax Revenues****OPTION 1 AND OPTION 3**

The number of impacted facilities is detailed in section VI.B.11.f. Aside from elimination of potential flood damage costs, the most significant impact of the flood reduction measures will be the protection of safety and emergency activities during a severe storm event. As detailed by Corps' report, the 1978 blizzard had severe impacts on vehicular access to damaged areas. Local roads, detailed in the next section, were rendered impassable.

**OPTION 2**

There will be impact to public facilities, services and tax revenues.

**g) Transportation****OPTION 1**

There will be no impact to the transportation network after the completion of Option 1. There will be an increase in flood-event transportation safety, however. A number of local roads which were flooded during the 1978 blizzard and the January 1987 storm would remain serviceable. Under Option 1 (in contrast to Option 3), Route 107 would still be subject to inundation.

The primary impacts on transportation would be during construction. Because Option 1 entails four local protection plans, the impacts on transportation (specifically, traffic disruption) are spread throughout the region.

There are four local protection plans designed for Option 1. These combined entail 45,555 linear feet (8.6 miles) of dikes and walls. The most prominent activity relative to transportation will be the number of truck trips (material hauling) generated. Table 22 shows the most trips for a particular area will be in the Lynn Harbor area and Revere Beach back shore. These will generate an average of 21 and 24 truck trips per day, respectively. Considering Route 1A in this region experiences nearly 20,000 vehicle trips per day, the trucking activity would pose only a minor impact.

The more significant impact to transportation created by Option 1 would be on local roads at the various construction sites. The duration of the project in total is less than 24 months (see Table 22).

### OPTION 3

Impacts on transportation will be primarily restricted to the Revere Beach area and focused primarily on the Lynnway. Of the three major arterial routes around or across the marsh system, only Route 1A will experience an impact by the construction activities associated with the floodgate project. According to the MAPC North Shore Transportation Task Force draft report (1/14/88), "Route 1A as a regional collector suffers from traversing several community center and commercial districts. Route 1A experiences congestion problems due to frequent left-turn maneuvers into and out of commercial driveways and side streets."

The most serious constraint to traffic flow presently is the ongoing reconstruction of the General Edwards Bridge. This work will be completed prior to the commencement of the floodgate project and traffic delays will be less than presently experienced with the reconstruction.

At present, however, the construction plan for cofferdams and eventually the floodgate involve primary dependence on barges for both a work platform and material hauling. If this method is used, there will be relatively little traffic interruption over the course of the project. According to the Corps, construction of a marine gate facility does not involve constant trucking activities (as does road building, for example). Building the flood structure across the river requires an enormous amount of steel reinforcement fabrication. Because of this, only small increments of concrete can be applied in a day. The Corps estimates that over the two years of major construction, the number of concrete trucks will average about four per day.

The construction of the Lynn and Revere dike and wall requires a greater trucking component. Over the course of the project (see Table 23) there will be on average 20 trips per day. The building of walls and dikes will have more of a negative impact on local non-arterial roads.

After construction, there will be no impact on traffic. There will, however, be a significant increase in the availability of safe access and evacuation routes during a major storm event. Route 107 (el. 9 to 10 feet MSL) will remain two to three feet above storm waters during a 100-year event. During the 1978 blizzard and the January 1987 flood, Route 107, Route 1A, and other local roads were under water.

## **OPTION 2**

Floodproofing of existing buildings will have a highly localized, site specific impact on traffic within the neighborhoods of each individual project. There should be no long term impacts on transportation.

## **h) Summary of Social and Economic Factors**

### **OPTION 1 AND 3**

The inducement to construction in the marsh will be nil due to the strict regulations under the Wetland Protection Act. Construction in the flood plain is presently not prohibited, only more costly due to building code requirements. If the flood plain were eliminated from the upland areas, there would be a minor economic incentive (lower construction cost) for development. Two things make this incentive relatively insignificant. First, other economic factors (interest rates, demand, etc.) outweigh reduced construction costs for deciding whether to build. Second, the scarcity of building sites shown by the developable lot study (360 residential, 163 zoned industrial, 57 commercial) means there would be relatively little change. Most significantly, all of these sites are developable now.

Property values would tend to rise due to reduction in insurance rates and the ability to rehabilitate existing structures without having to raise them to current 100-year flood levels.

After the completion of the project, there will be little or no impact to population growth, employment or industrial activity. Transportation in general would not be affected, except that safe access would be available over low-lying local roads (Route 104 and Route 107 under Option 3) during major storm events.

The construction activity will have a localized negative impact with regard to traffic and noise. These will last the duration of the project (about 24 months for both Options).

**OPTION 2**

Floodproofing of about eight percent of the existing structures in the study area would create no significant social or economic impacts. The impacts would be highly site-specific (it is most likely Option 2 alone would not meet a MEPA threshold requiring review).

## **VII. A. 12. Navigation**

**VII. A. 13. Recreation and Open Space**

### 13. Recreation and Open Space - Study Area

#### OPTION 1 AND OPTION 3

Option 1, with its many miles of dike and wall construction, may impact access to the marsh and rivers

With the completion of the flood stage reduction project, recreation and open space opportunities will be only mildly impacted. Since the primary construction activities of the project would be on the ocean side of the marsh, the interior area would not be modified. Access to the marsh is limited mostly to marine service businesses along the rivers. This would not change as a direct impact of the project. Knowing flood damage potential was reduced, communities surrounding the marsh may be encouraged to put into effect their recreational plans as described in Section VI.B.13 above. Several communities have, through their master plans, indicated a recommendation to change the zoning of the marsh and its surrounds from industrial to open space/conservation.

The Saugus and Pines River are popular sport fishing areas. Recreational boating will not be greatly impacted, as traditional access points will not be modified. The floodgate would not significantly change tidal velocities at the structure, but not enough to restrict sailboats, the slower of recreational boats, which average 5 to 6 knots (although several correspondents raised concerns about vessels only under power of sail having 100 feet to maneuver through the gate). It should be noted that the navigation opening under the General Edwards Bridge is presently 100 feet.

The Revere Beach area would be the greatest benefactor in terms of recreational enhancement to the development of the Dike Parkland. The development of the Dike Parkland has been described in detail by the Corps of Engineers and by the Metropolitan District Commission's 1978 Master Plan.

It would be located over the flood protection embankment to be constructed between Revere Beach Boulevard and Ocean Avenue, from Shirley Avenue to Revere Street. The park would serve passive uses encompassing walkways, gardens, play equipment, and other similar amenities. Annual benefits from the Parkland are estimated as 121,020 activity days per year times the unit day value of \$3.32 or approximately \$401,000 (Corps of Engineers, 1988).

Presently there are numerous boatyards and marina facilities on the rivers, the largest of which are in Revere along Route 1A. The installation of the flood reduction project would not negatively impact their operations, according to discussions with operators and boat owners.

#### **OPTION 2**

There would be no significant impact to recreation and open space with the floodproofing of existing buildings.

## **VII. A. 14. Noise**

## **14. Noise**

### **OPTION 1**

Noise from construction will be due primarily to trucking and heavy equipment operation in building the dikes and walls. These impacts are similar to and more carefully detailed for Option 3. Option 1 differs in the extensive area impact of the construction. Noise will impact more neighborhood areas in order to complete over eight miles of construction.

### **OPTION 3**

#### **a) Construction**

Construction activity will cause the only significant noise interference with the ambient environment. The prominent activities associated with higher decibel counts are metal reinforcement fabrication, cement operation (primarily trucks in pumping mode), other trucking operations and heavy equipment. However, the flood gate construction would require, on average, less than five truck loads of concrete per day.

If the work is carried out from barges, there would be considerably less trucking activity and the associated noise.

#### **b) Floodgate**

The preferred location for the floodgates is at the mouth of the Saugus River. The nearest residential section is located in Point of Pines, adjacent to the flood gates. Noise heard at Point of Pines would be similar to that from the compressors and work currently on going at the General Edwards Bridge.

On the northern side to the east of the bridge is the Bayside Inn. The proprietor said that the construction activity ongoing for the Lynnway repair does not disturb their motel operation. She noted their primary operation was at night when construction activity had essentially ceased as would likely be the case with the floodgate.

**c) Lynn Harbor, Revere Beach and Point of Pines**

Approximately 7,700 feet of dikes and walls would be constructed in this area along the shoreline. The area is a business/industrial region. No residential areas are close by. The noise impacts are the same, though of less concentrated frequency, as with the floodgate. No significant impact is anticipated.

The Revere Beach area is residential and will be impacted by the trucking activities generated in the dike building. The same is true of the Point of Pines wall project.

**d) Post Construction Impacts**

After completion, the project itself will have minimal noise implications. The operations of the floodgate would have occurred on average, 2 to 3 times per year over the last 11-year period (Source: Army Corps of Engineers). The movement of the water through the gate when open, which is most of the time, is in the low decibel range similar to water passing under the General Edwards Bridge. General repairs over the life of the gate would entail similar noises, though smaller in duration, as those during initial construction.

**OPTION 2**

Noise associated with floodproofing of structures are those of any building construction. Impact would be localized and vary considerably from site to site depending on the requirements for floodproofing.

**VII. A. 15. Air Quality**

## **15. Air Quality**

### **OPTION 1 AND OPTION 3**

#### **a) Dust**

Typically, the most significant air quality impact from construction activities of this type is from dust raised by heavy equipment and trucking. The impacts associated with dust are respiratory irritation, degradation of sensitive mechanisms, and dirtiness. There are several automobile sales operations downwind of the Option 3 Lynn Harbor dike. Autos are stored outside and dealers would be the most likely to raise a concern.

According to the Corps, the floodgates may be built largely from barges. Cement and other materials would be transported to the site on these barges. If this is the case, there would be relatively little trucking activity near the site for the better part of the project.

Fortunately, dust is the easiest pollutant source to mitigate.

#### **b) Emissions**

Emission impacts for construction activities on the project are the result of internal combustion engines. Generally, the impact from emissions is predicted to be negligible in light of present ambient standards.

The construction area is adjacent to the seashore. The prevailing wind in the area is southwest. Thus, most emissions will be transported offshore.

The following is a list of specific emissions associated with internal combustion engines:

**(1) Carbon Monoxide**

Odorless, poisonous, CO is the result of incomplete combustion of fossil fuels. CO binds very strongly to the hemoglobin and prevents the hemoglobin from carrying O<sub>2</sub> resulting in oxidation deprivation.

**(2) Oxides of Nitrogen**

Generated by internal combustion, the nitrogen is derived from the air as opposed to the fuel. NO<sub>x</sub> production is not a serious problem to people at present levels. It is an important ingredient to the generation of photochemical oxidants. The project will not generate significant levels.

**(3) Sulfur Dioxide**

Result of burning fossil fuels. SO<sub>2</sub> is colorless, with a suffocating odor. The various oxides are harmful to animals, plants, and structural materials. The chemical acts as an irritant especially for people with upper respiratory dysfunctions. Oxides of sulfur are primarily released with burning of coal. Not a significant emission with this project.

**(4) Particulates**

This category is a catchall for solid matter particles pushed into the atmosphere. They include: flyash; metals such as lead, cadmium, nickel, and mercury; asbestos, and; dust. The only significant particulate anticipated to be generated by the construction activity is dust, which has been discussed in subsection a) above.

**(5) Hydrocarbons**

Wide variety of pollutants generated, in the study area, by internal combustion. These are important elements in the creation of photochemical oxidation. Again, significant levels will not be produced.

**(6) Photochemical Oxidants**

Smog, the interaction of hydrocarbons, oxides of nitrogen, and oxygen in the presence of the sun's ultraviolet light. Refer to Table 22, in Section VI.B.15. Localized impacts are dependent on circulation (or stagnation) of air. The construction sites are not in contained spaces, but open to wind transport.

**c) Post Construction**

The operation of the floodgates will be powered by generators. Because these gates would be operated so infrequently, there would be no significant impact to air quality.

**OPTION 2**

There would be no significant impact to air quality.

## **IX. Sea Level Rise - A Sensitivity Analysis**

Sea level rise will have three major types of physical effects in most coastal communities: shoreline retreat, increased flooding, and landward movement of salt water (Hoffman, et al., 1983). For the Saugus and Pines Rivers estuary and the associated flood plain, the primary impact will be increased flooding. Low-lying areas not lost to a rising sea will experience increased flooding generally because a high sea level will provide a higher base on which storm surges can build and because high water tables will decrease the land's drainage capacity increasing runoff during storms (Hoffman, 1983). Shoreline retreat will be a secondary impact as it relates to beach erosion along Revere Beach.

The impact of salt water intrusion is considered negligible for this area since private wells are not used around the estuary. The potential effects of public water supply degradation may be more significant to a larger, more widespread area, therefore, it is beyond the scope of this sensitivity analysis.

This generic assessment of the impacts of sea level rise with and without a Federal flood control project includes a discussion of some of the categories of decisions that sea level rise will influence growth and development in the flood zones of Lynn, Saugus, and Revere (Table 25).

### **A. Affected Environment**

#### **1. Minimum Sea Level Rise Effects**

Future conditions without a federal project under the historical rate of a one-foot rise of sea level have been assessed.

**Table 25****CATEGORIES OF DECISIONS SEA LEVEL RISE  
WILL INFLUENCE (HOFFMAN, ET AL., 1983)****LOCATIONAL DECISIONS**

- **WHERE TO PUT PRIVATE DEVELOPMENT AND REDEVELOPMENT**
  - HOUSING
  - FACTORIES
  - RESORTS
  - ENERGY FACILITIES
  - HAZARDOUS WASTE SITES
- **PUBLIC DEVELOPMENT DECISIONS—ROADS**
  - UTILITIES
  - PORT INFRASTRUCTURES
  - PARKS
  - BRIDGES
- **PURCHASE OF LANDS FOR CONSERVATION**

**STRUCTURAL AND SITE DESIGN DECISIONS**

- **HOW TO BUILD FACILITIES**
  - THEIR MOVABILITY
  - SITE CONTOURING
  - CONSTRUCTION TYPE AND QUALITY
  - PLANNED LIFETIME OF STRUCTURE
- **R&D ON HOW TO IMPROVE OPTIONS**
  - SUCH AS MAKING STRUCTURES MORE "SEA LEVEL RESISTANT"
  - MAKING STRUCTURES MOVE MOVABLE
- **HOW TO MAKE LOW-COST DESIGN CHANGES TO REDUCE ADVERSE EFFECTS**

**PROTECTIVE MEASURES AGAINST FLOODS AND EROSION**

- **PROTECTIVE FACILITIES SUCH AS SEAWALLS**
  - HEIGHT
  - TYPE
  - FOUNDATION SIZE (SO THEY CAN BE EXPANDED LATER)
- **BEACH NOURISHMENT DECISIONS**
- **VEGETATION PLANTING AND MAINTENANCE DECISIONS**
- **RIVER CHANNELING AND RECHANNELING DECISIONS**
- **LAND ACQUISITION AND SET ASIDE FOR PUBLIC AND PRIVATE WORKS FOR FUTURE PROTECTION**
- **LOCAL ZONING AND OTHER LAND-USE CONTROLS TO REDUCE DEVELOPMENT IN WRONG AREAS**
- **FLOOD PROTECTION REQUIREMENTS FOR HAZARDOUS FACILITIES**

**DECISIONS ABOUT FLOOD MITIGATION PLANNING**

- **EVACUATION PLANS**
- **POST-DISASTER PLANS**
- **INSURANCE POLICIES, SUBSIDIES AND COSTS**

All flood zones adjacent to the marsh system and along the Upper Saugus River and Shute Brook would be affected. Frequently occurring storms would become more of a nuisance for individual residents located along the marsh in Saugus. Commercial and industrial development in Lynn would also be more affected. In both cases, flood proofing efforts would likely increase (as well as raising, rebuilding, and widening the 30 miles of shoreline structures around the estuary and shorefront) as an adjustment to the incremental increase of nuisance flooding. Extreme measures such as building abandonment, relocation, or a halt to new building would depend on implementation of state and local regulations as demonstrated in the recent Chatham, Massachusetts, decisions.

Beach erosion along the shoreline of Revere would be exacerbated and the long-term requirement for beach nourishment would need to be addressed. The question of shoreline retreat, however, is not relevant since the barrier is stabilized by an existing seawall that would be maintained and a high level of development. More rapid deterioration of Revere Beach seawall and severe overtopping would occur. Wave damage potential for the existing development behind the seawall would be greater as well.

## **2. Accelerated Sea Level Rise Effects**

Future conditions without a Federal project under scenarios of more than one to nine feet over the 100 year life of the project have been assessed using other projections (Hoffman et al., 1983) that are considered to be worst case. These four scenarios of future sea level rise before 2088 are: high (8.5 feet); mid-range high (5.5 feet); mid-range low (3.6 feet) and low (1.4 feet).

Increased flooding because a higher sea level will provide a higher base on which storm surges can build will have the most dramatic impact in the study area for two reasons: 1) Revere Beach, as a barrier beach, will provide

less protection of landward areas from storm damage since it will be overtopped more frequently and 2) the depth of water in the marsh system will be able to accommodate breaking waves.

The already low (i.e., 10-15 MSL) topography and heavily developed barrier beach in Revere will most likely be maintained to the point that storm damage costs outweigh the reasons to rebuild. Natural landward migration and upward building of the barrier beach which would typically occur with sea level rise will not because the barrier is stabilized. The seawall will reduce the amount of overwash sedimentation and that which does pass over the wall would be cleared from the streets and yards to maintain existing grades. Over time, the desire for beach nourishment, seawall improvements, elevated structures and use of Route 1A will most likely shift to the eventual abandonment of the barrier beach if a large accelerated sea level increase occurs.

An accelerated sea level rise will not allow for vertical sedimentation or the upward building of the marsh to occur at a similar rate, therefore, the depth of flood waters in the estuary will be proportionately greater than what currently exists. Combined with the lowering and overtopping of the barrier beach, the increased depths will allow for the development of wind driven waves in the estuary. Once sea level has increased about 4.5 feet (i.e., half the tidal range) and mean sea level is located at the upland border of the existing salt marsh, it is likely that storm waves would have an impact on existing developed areas. In particular, northeast facing shorelines (North Gate Flood Zones 1 and 2) will be the most vulnerable to wind driven waves by northeast storms. Whereas, the estuarine shoreline of Lynn will be exposed to southerly winds associated with hurricanes. The existence of the stable, I-95 embankment will protect the line of homes along the marsh side of East in Saugus from any flood damage due to wind generated wave impacts.

Relocation of homes and abandonment of all residential neighborhoods in the flood zones of Revere and Saugus will occur over time. Local flood control projects adjacent to existing commercial and industrial development may be an alternative to abandonment in Lynn (Flood Zones 1 and 2) in particular.

## **B. Environmental Effects of Detailed Plans**

### **1. Minimum Sea Level Rise Effects**

The historical projections of future sea level rise represent minimum changes (i.e., one-foot sea level rise within 100 years) upon which to evaluate the generic impacts of the three proposed options for flood control in the Saugus and Pines Rivers estuary. One important assumption applies to the structural options (1 and 3) as a result of past New England Division policy regarding a factor of safety. That is, any concrete wall and earthen dikes are built two or three feet, respectively, above design still water level, where minimal wave damage is expected. Where significant wave action is likely, the height is increased to reduce wave overtopping to manageable amounts. In light of historic sea level rise of about one foot per century, the Corps is recommending that a factor of safety of no less than three feet be added to design stillwater level for all Saugus and Pines Rivers area tidal protection and that all structures be designed to withstand some degree of wave overtopping.

The impact of a minimum sea level rise on the study area for Option 1 will be negligible for those area of Revere Beach backshore, Lynn, East Saugus and Town Line Brook which will be protected by a total of 8.6 miles of earthen dikes or concrete wall structures, given the factor of safety design. However, the flood zones not protected by such structures includes North Gate 1 and 2, Lynn 4, Saugus 1B and C, and the Upper Saugus River and Shute Brook areas.

The study area with a nonstructural plan (Option 2) that has about eight percent of the structures in the 100-year flood plain being raised or flood proofed would be exposed to the same impacts as those discussed in the previous section on Affected Environment, excluding the protected structures up to the current 100-year flood elevation. The elevated structures would receive a foot of water above the first floor unless they were designed to meet the minimum sea level rise projection. The flood preparedness plans of the option would be utilized more often because of the increased effects of high frequency events (i.e., wave overtopping will occur). These plans would not mitigate the impact of increased nuisance flooding as discussed previously and residents would still need to be evacuated if the area were flooded.

All zones in the study area would be significantly protected from a minimum sea level rise with Option 3. Only the ocean front areas at the north end of Revere (Flood Zone 5b) will be effected but to a lesser degree with the project. Most importantly, however, the entire estuary shoreline of Lynn, Saugus, and Revere will be protected from flooding because of the floodgate structure in the Saugus River. The gate would be operated more frequently with the minimum sea level rise projection.

## **2. Accelerated Sea Level Rise Effects**

The EPA projection (Hoffman et al., 1983) of future sea level rise represent the maximum changes (i.e., more than one to nine feet sea level rise over 100 years) upon which to evaluate the generic impacts of the three proposed options. Given the factor of safety design of all flood control structures (Options 1 and 3) more than negligible effects will begin when sea level exceeds three feet or the factor of safety unless shorefront structures are raised over the course of sea level rise.

The impacts of a maximum sea level rise in the study area with Option 1 would include the reduction of possible wave impacts in the estuary because of the flood control structures in Revere Beach backshore but an increase in impounded flood waters that overtop Revere Beach which would be trapped by those same structures, therefore, necessitating additional works such as gates and pumps. In the case of separate local protection projects the closure of flap gates and ponding of interior runoff will become more frequent. Large increase in sea level might necessitate the addition of pumping stations to pump interior runoff through the line of protection. Finally, decisions to abandon Revere Beach would be prolonged with the existence of the flood control structures.

The study area with Option 2 would slowly lose most all benefits as sea level rise increased above the protection limits of the elevated and flood proofed structures.

With Option 3 and a large sea level rise, normal nonstorm high tides would necessitate very frequent closure of tidal flood gates during nonstorm periods to protect low lying residential areas. Frequent flood gate closure in this instance may slow the progression of salt marsh into tidal mud flats by minimizing frequent periods of prolonged inundation. Additionally, increased wave overtopping entering the backshore ponding area may necessitate earlier closure of tidal flood gates during storms to assure that ample ponding area is available or raising the shorefront to reduce overtopping. The large amount of storage available makes it unlikely that large sea level rise would mandate the addition of pumps at the floodgate structure to carry interior runoff although this possibility cannot be ruled out.

In conclusion, effects on the growth and development potential of uplands surrounding the Saugus and Pines Rivers estuary with and without a federal flood control project have been discussed in sections VI and VII of this

report. With a minimum sea level rise of one foot within 100 years, the change in those effects will be minimal. With a maximum sea level rise of significantly more than one foot, however, several significant effects can be predicted. There will be increased beach erosion, higher storm waves and increased runup and overtopping of Revere Beach, with and without a federal flood control project. The flood damage potential from waves set up in the estuary and increased flooding of broad, low lying areas in Saugus and Lynn would likely occur without the project. It is this wave damage potential and salt water flooding around the estuary that would be significantly reduced with Option 1 and 3.

## **IX. Sea Level Rise - A Sensitivity** **Analysis**

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## **Appendix A**



## APPENDIX A

### Preliminary Assessment of Wetland Filling

**APPENDIX A-1****Wetland Community Types****SUBTIDAL HABITATS**

TR: Tidal River  
PND: Pond (in part)

**IRREGULARLY EXPOSED HABITATS**

MF: Mud Flat (in part)  
CR: Creek  
PND: Pond (in part)

**REGULARLY FLOODED HABITATS**

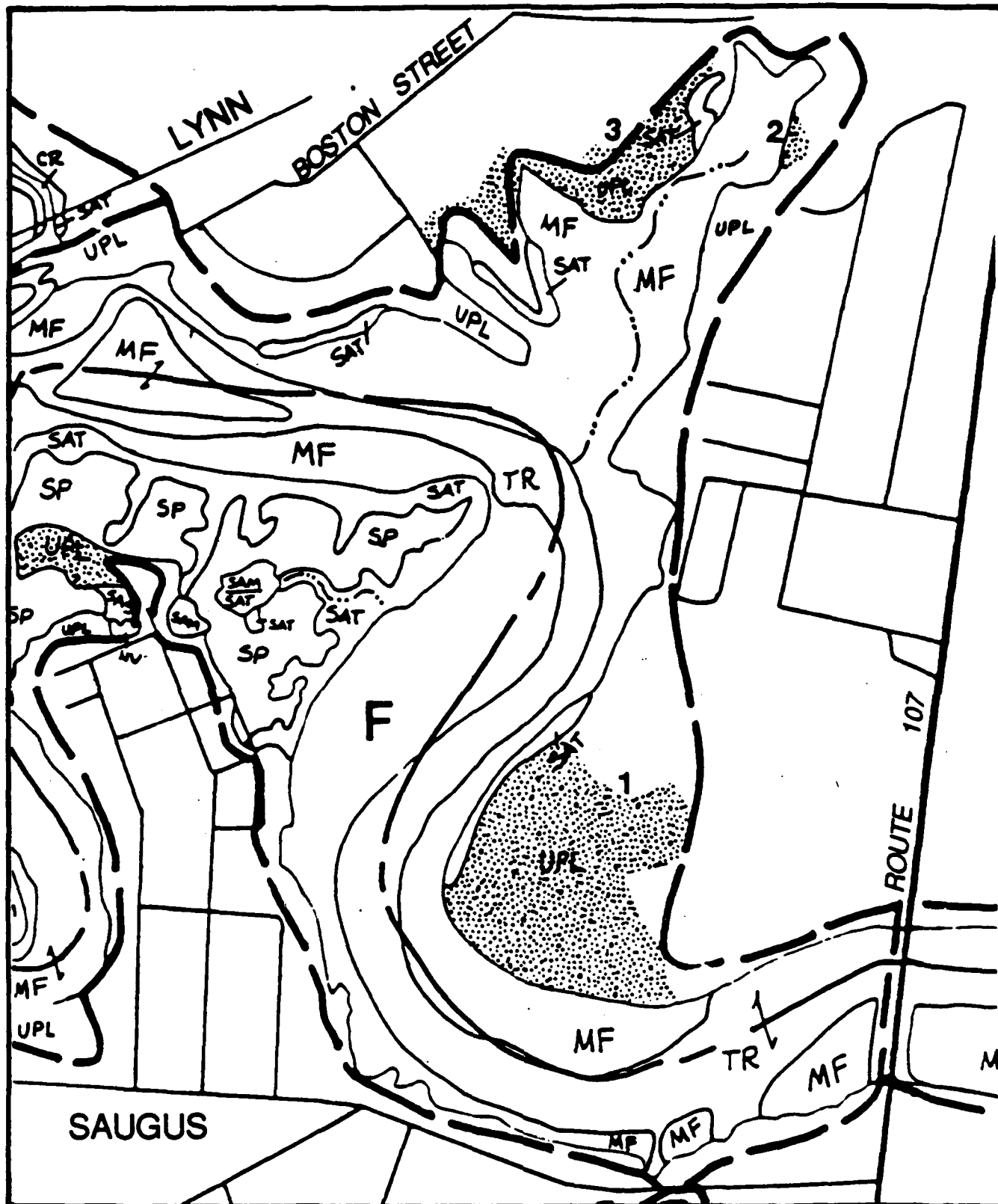
SAT: Spartina alterniflora, tall form (>0.8 m), dominates  
FF: Mud Flat (in part)

**IRREGULARLY FLOODED HABITATS**

HM: High Marsh, undifferentiated  
SP: Spartina patens dominates  
DS: Distichlis spicata dominates  
JG: Juncus gerardii dominates  
SAS: Spartina alterniflora, short form (<0.3m), dominates  
SAM: Spartina alterniflora, mid-height (0.3m-0.8m), dominates  
IF: Iva frutescens dominates  
TY: Typha spp. dominates  
PH: Phragmites australis dominates  
LS: Lythrum salicaria dominates  
BM: Brackish Marsh (mixed composition)  
PAN: Panne  
NV: Non-vegetated

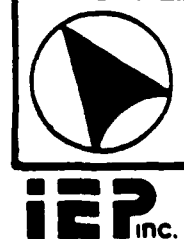
**SEASONALLY FLOODED FRESHWATER HABITATS**

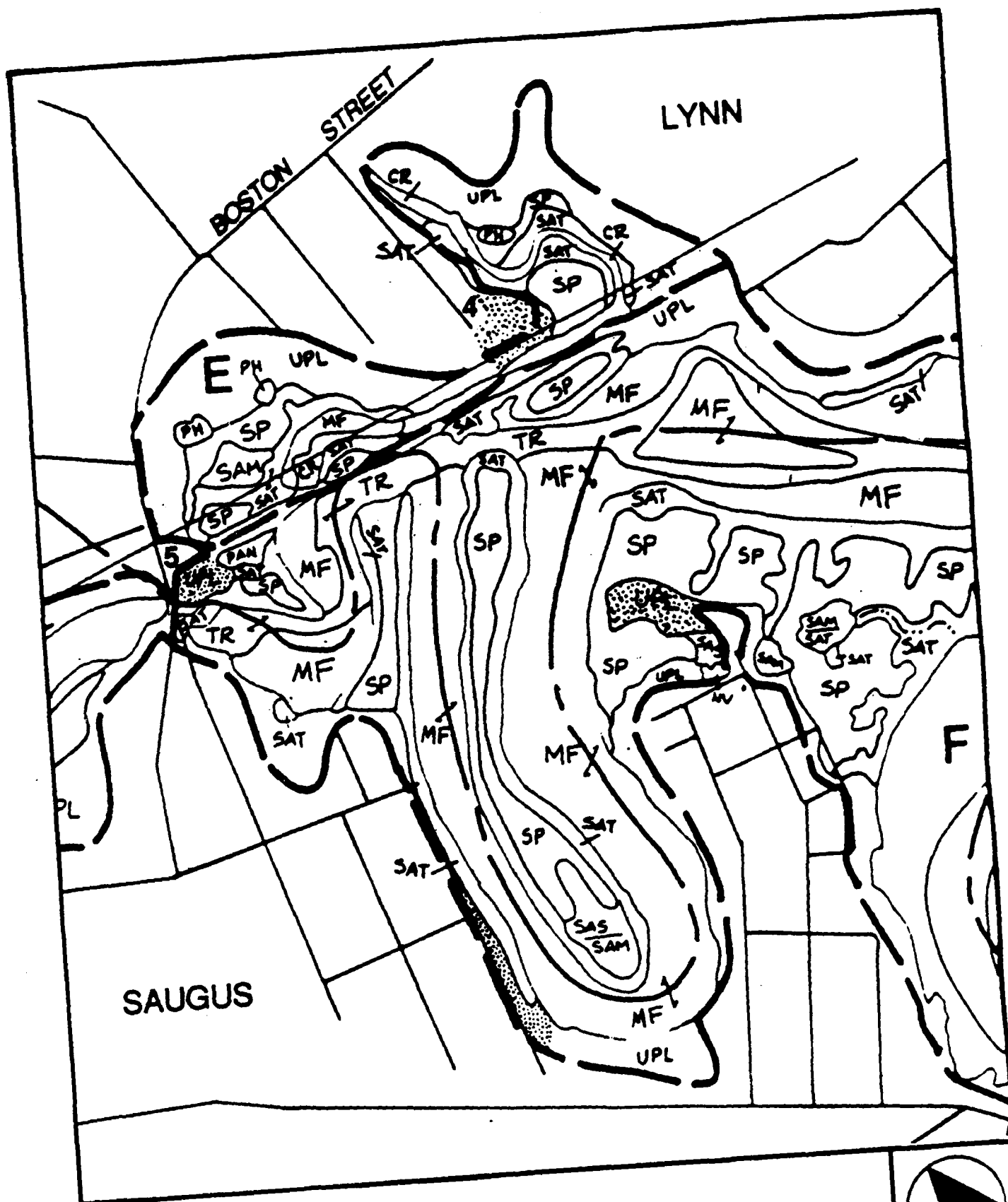
SS: Shrub Swamp  
WS: Wooded Swamp



**APPENDIX A-2:  
SPECIFIC LOCATION OF  
WETLAND FILLING IN  
LYNN (1978-1987) AREAS 1, 2, AND 3**

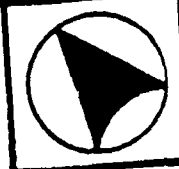
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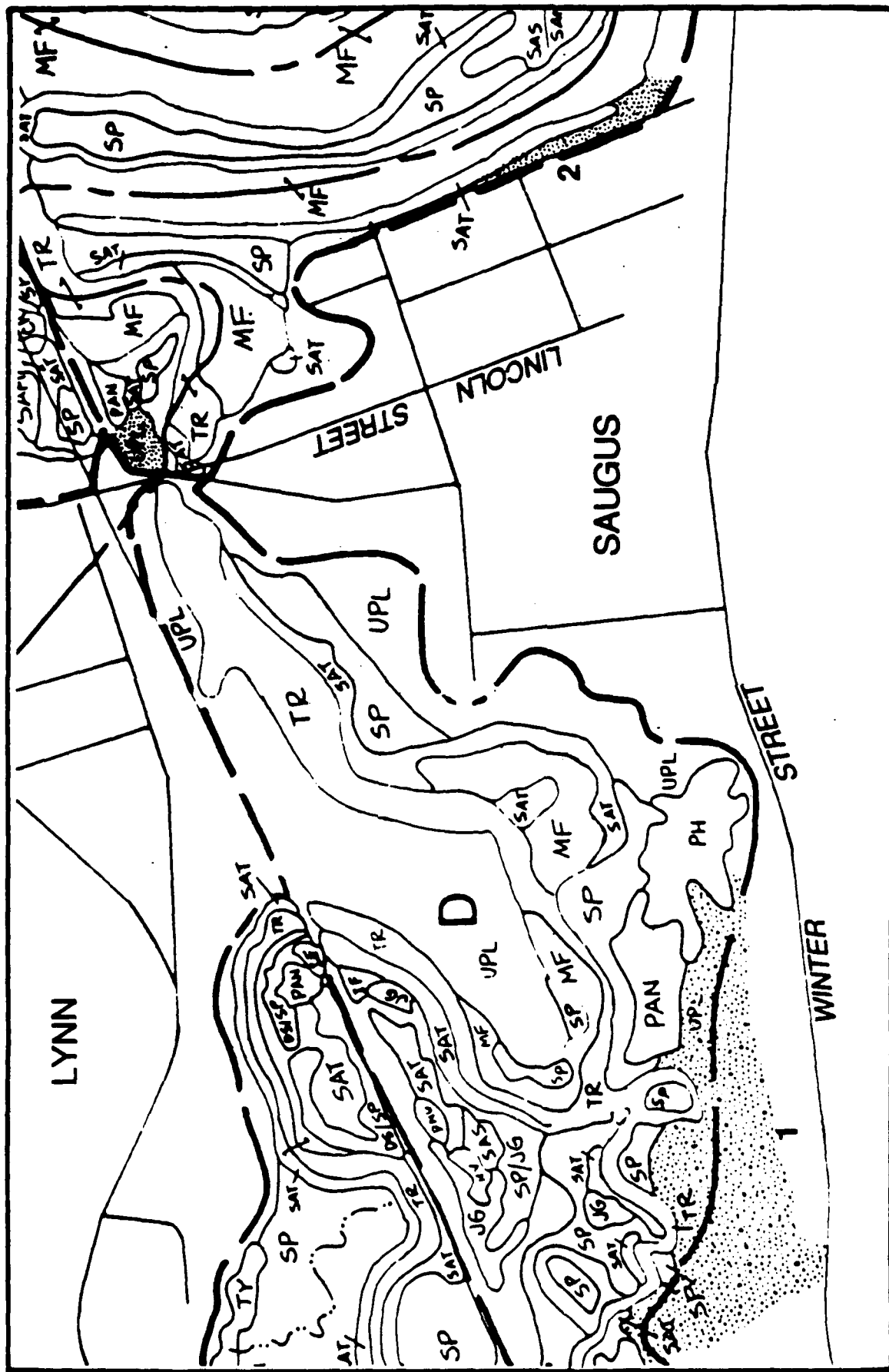


**APPENDIX A-3:  
SPECIFIC LOCATION OF  
WETLAND FILLING IN  
LYNN (1978-1987) AREAS 4 AND 5**

APPROXIMATE SCALE IN FEET  
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**IEP** inc.

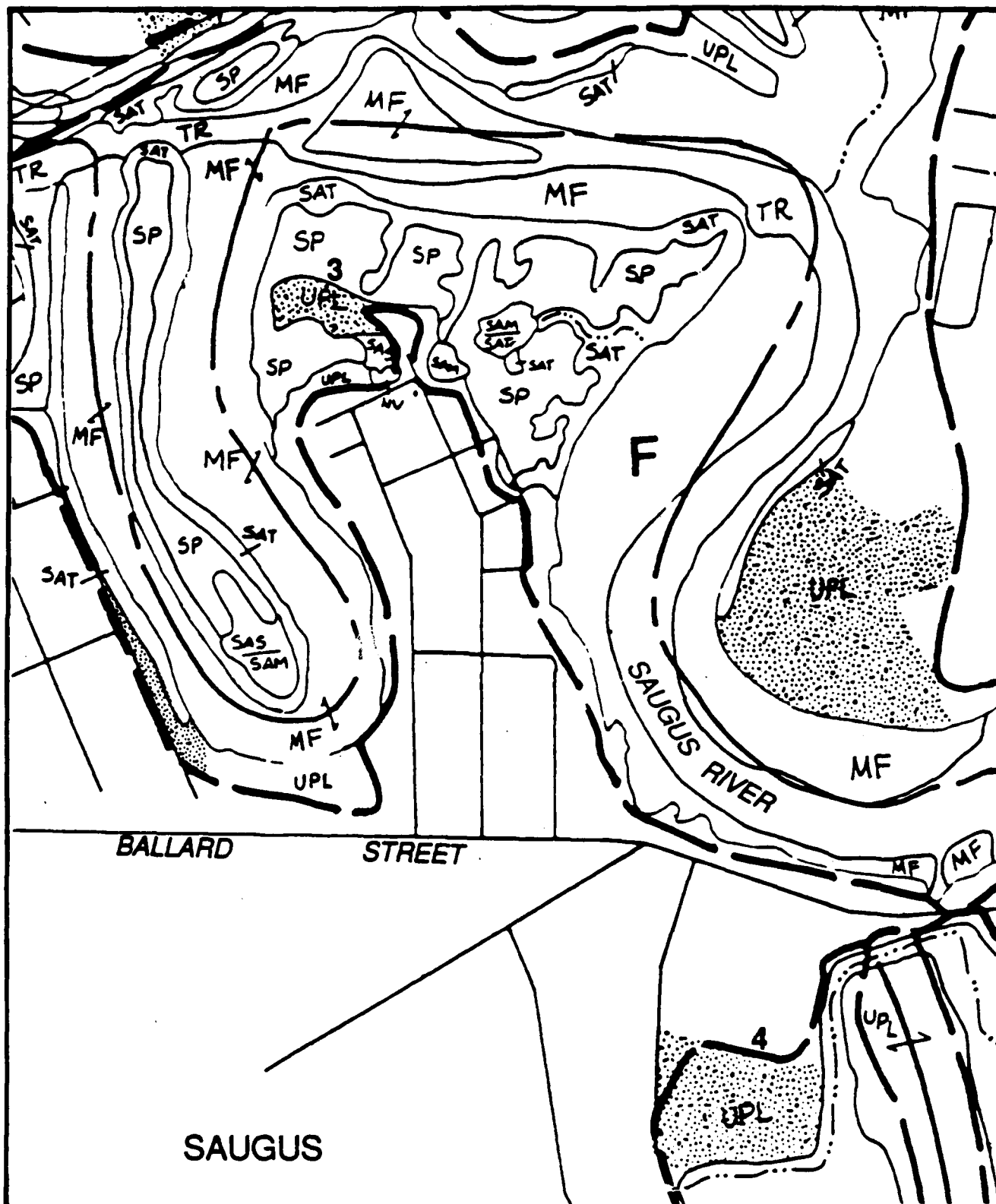


**APPENDIX A-4: AREAS 1 AND 2  
SPECIFIC LOCATION OF WETLAND  
FILLING IN SAUGUS (1978-1987)**

APPROXIMATE SCALE IN FEET  
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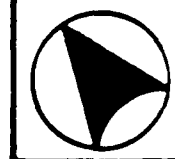


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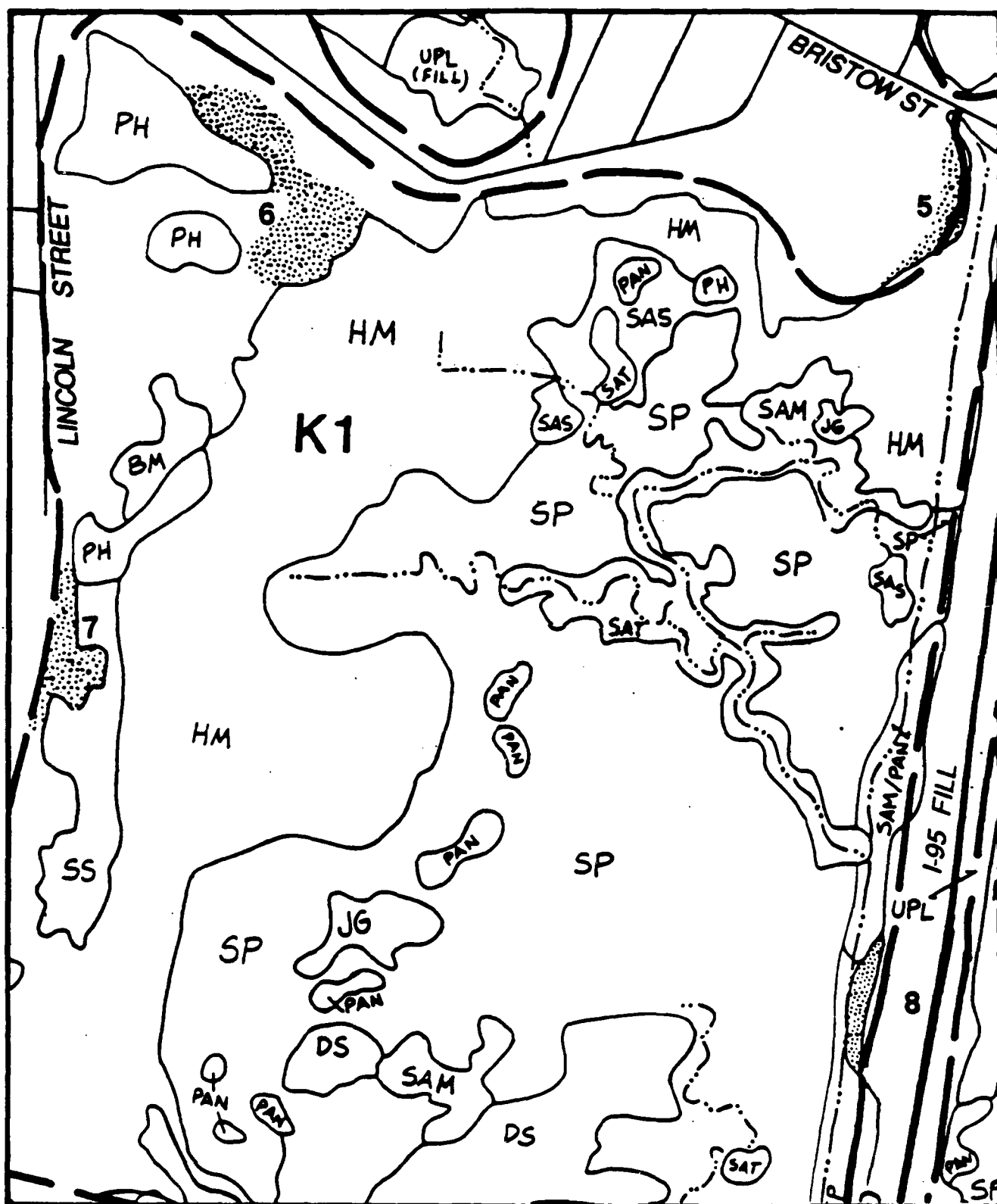


**APPENDIX A-5:  
SPECIFIC LOCATION OF  
WETLAND FILLING IN  
SAUGUS (1978-1987) AREAS 3 AND 4**

APPROXIMATE SCALE IN FEET

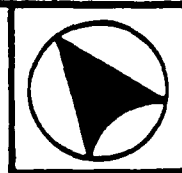


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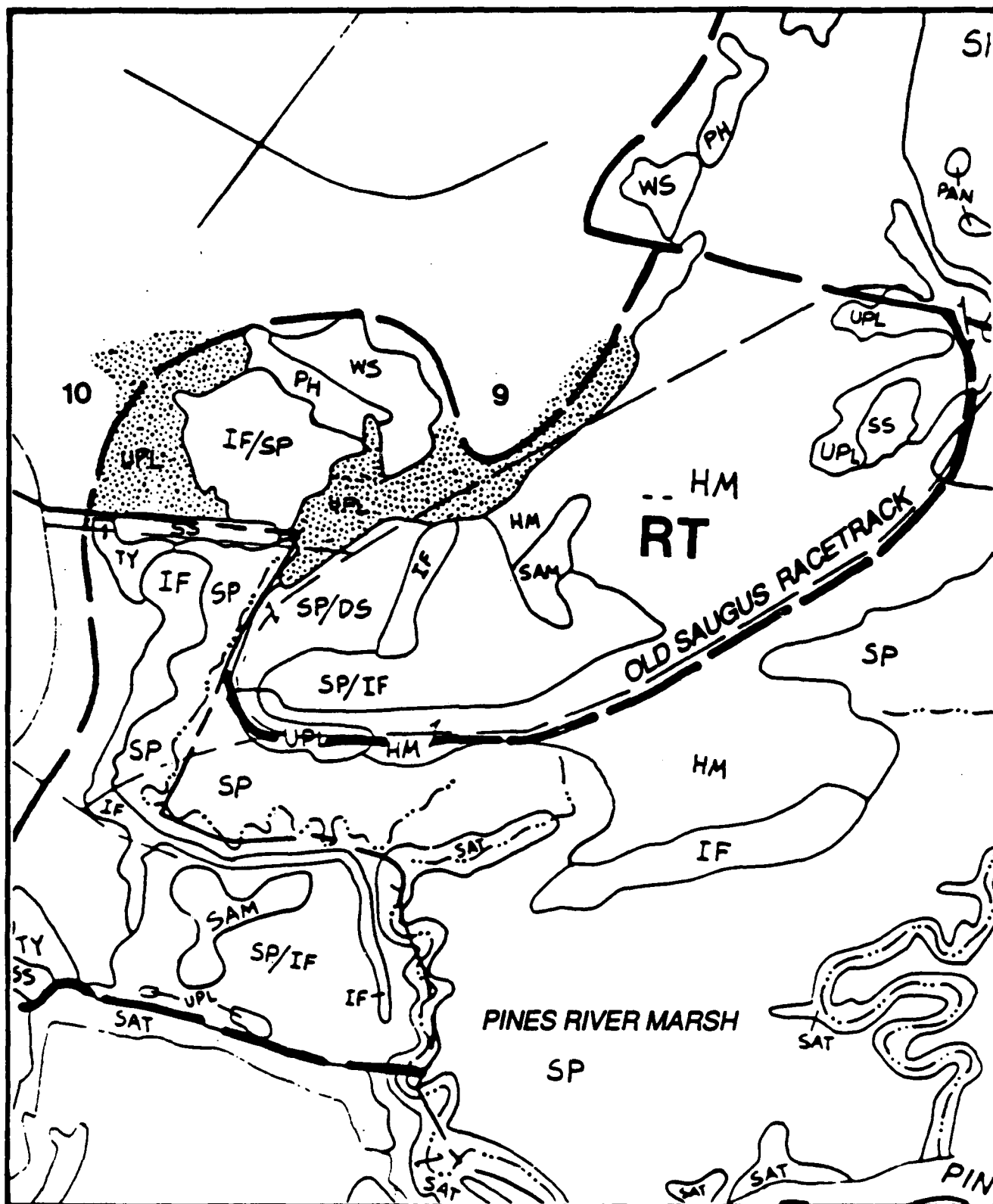


**APPENDIX A-6:**  
**SPECIFIC LOCATION OF**  
**WETLAND FILLING IN**  
**SAUGUS (1978-1987) AREAS 5, 6, 7 AND 8**

APPROXIMATE SCALE IN FEET

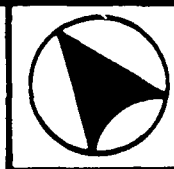


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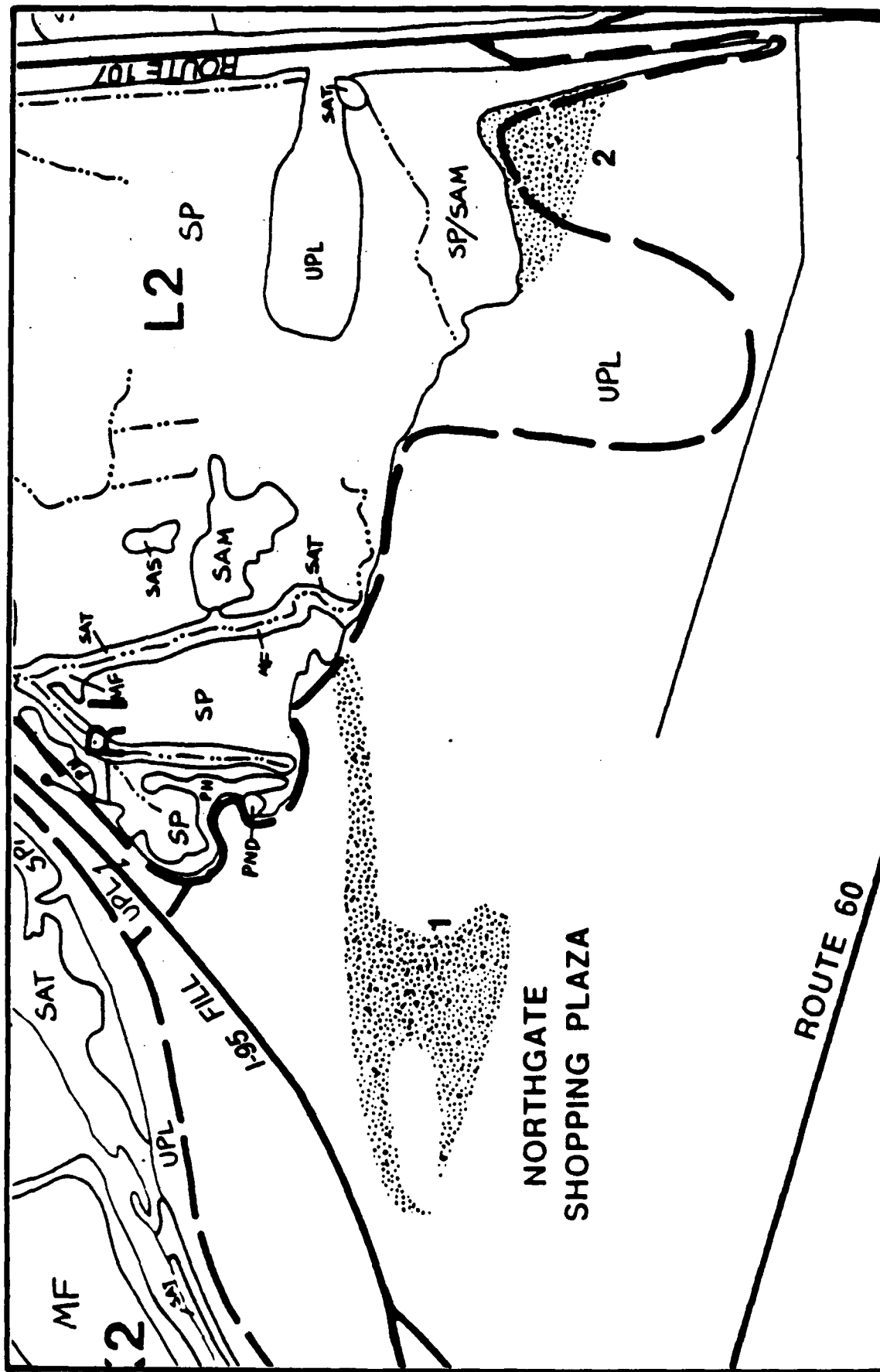


**APPENDIX A-7:  
SPECIFIC LOCATION OF  
WETLAND FILLING IN  
SAUGUS (1978-1987) AREAS 9 AND 10**

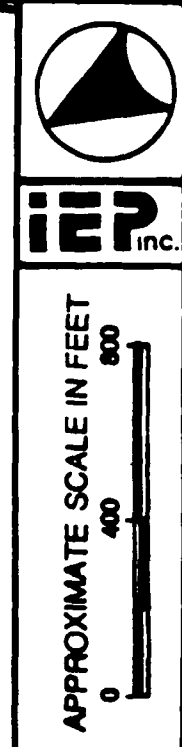
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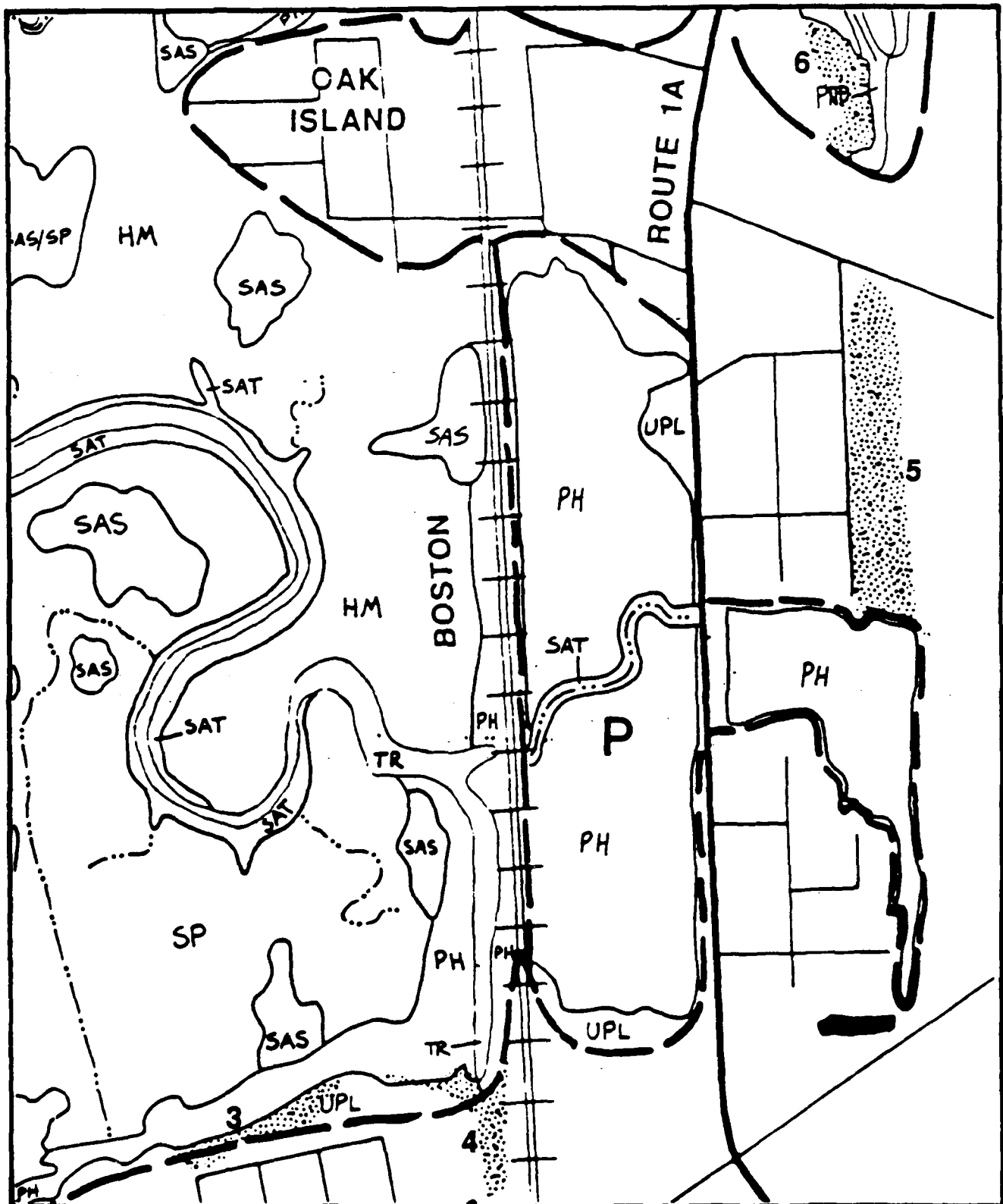


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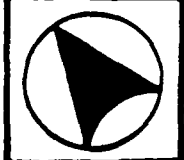
**APPENDIX A-8: AREAS 1 AND 2  
SPECIFIC LOCATION OF WETLAND  
FILLING IN REVERE (1978-1987)**



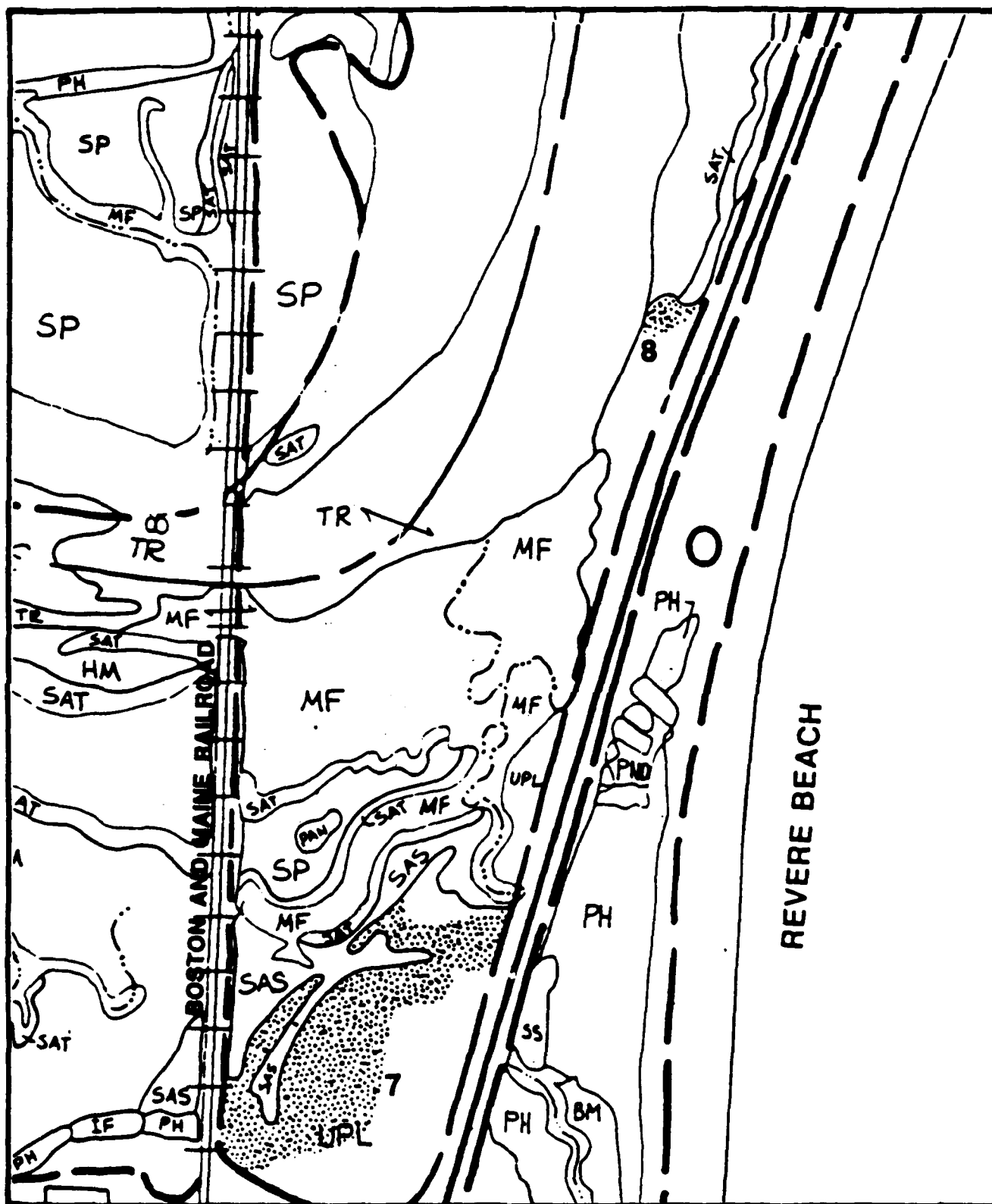


**APPENDIX A-9:  
SPECIFIC LOCATION OF  
WETLAND FILLING IN  
REVERE (1978-1987) AREAS 3, 4, 5 AND 6**

APPROXIMATE SCALE IN FEET  
0 400 800



**IEP** inc.



**APPENDIX A-10:  
SPECIFIC LOCATION OF  
WETLAND FILLING IN  
REVERE (1978-1987) AREAS 7 AND 8**

APPROXIMATE SCALE IN FEET  
0 400 800



**IEP** inc.

